

Digitized by the Internet Archive
in 2016

JOURNAL

OF THE

SOCIETY OF ARTS.

VOLUME XXXIX.

FROM NOVEMBER ²¹~~14~~, 1890, TO NOVEMBER 13, 1891.



LONDON:

PUBLISHED FOR THE SOCIETY BY GEORGE BELL AND SONS,
4, 5, & 6, YORK STREET, COVENT GARDEN.

1891.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1983.]

FRIDAY, NOVEMBER 21, 1890.

[Vol. XXXIX.

ONE-HUNDRED-AND-THIRTY-SEVENTH SESSION, 1890-91.

COUNCIL.

H.R.H. THE PRINCE OF WALES, K.G., *President of the Society.*

THE ATTORNEY-GENERAL, M.P., *Vice-President and Chairman of the Council.*

SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., *Deputy-Chairman of the Council and Treasurer.*

H.R.H. THE DUKE OF EDINBURGH, K.G., *Vice-Pres.*

H.R.H. THE DUKE OF CLARENCE AND AVONDALE, K.G.,
Vice-Pres.

THE DUKE OF ABERCORN, C.B., *Vice-Pres.*

WILLIAM ANDERSON, M.Inst.C.E., *Vice-Pres.*

SIR FRANCIS DILLON BELL, K.C.M.G., C.B., *Vice-Pres.*

SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D.

SIR EDWARD BIRKBECK, Bart., M.P., *Vice-Pres.*

MAJOR-GEN. SIR OWEN TUDOR BURNE, K.C.S.I., C.I.E.,
Vice-Pres.

ALFRED CARPMAEL, *Vice-Pres.*

MICHAEL CARTEIGHE.

R. BRUDENELL CARTER, F.R.C.S., *Vice-Pres.*

SIR GEORGE HAYTER CHUBB.

LORD ALFRED S. CHURCHILL, *Vice-Pres.*

B. FRANCIS COBB, *Vice-Pres.*

SIR DANIEL COOPER, Bart., G.C.M.G., *Vice-Pres.*

SIR PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E.,
Vice-Pres.

PROFESSOR JAMES DEWAR, M.A., F.R.S., *Vice-Pres.*

SIR HENRY DOULTON, *Vice-Pres.*

JAMES DREDGE.

JAMES STAATS FORBES, *Vice-Pres.*

SIR DOUGLAS GALTON, K.C.B., D.C.L., F.R.S., *Vice-Pres.*

THOMAS HAWKSLEY, F.R.S., *Vice-Pres.*

A. B. W. KENNEDY, F.R.S.

CHARLES MALCOLM KENNEDY, C.B.

SIR VILLIERS LISTER, K.C.M.G., *Vice-Pres.*

JOHN BIDDULPH MARTIN.

GEORGE MATTHEY, F.R.S.

LIEUT.-GENERAL J. MICHAEL, C.S.I.

JOHN FLETCHER MOULTON, Q.C., F.R.S.

GENERAL THE RIGHT HON. SIR HENRY F. PONSONBY,
G.C.B., *Vice-Pres.*

WILLIAM HENRY PREECE, F.R.S.

SIR ROBERT RAWLINSON, K.C.B., *Vice-Pres.*

SIR OWEN ROBERTS, M.A., F.S.A., *Treasurer.*

EDWARD C. ROBINS, F.S.A.

LORD THURLOW, F.R.S., *Vice-Pres.*

SECRETARY.

SIR HENRY TRUEMAN WOOD, M.A.

ASSISTANT SECRETARY.

HENRY R. WHEATLEY, F.S.A.

ACCOUNTANT.

HOWARD H. ROOM.

AUDITORS.

J. OLDFIELD CHADWICK AND SON.

SESSIONAL ARRANGEMENTS.

The First Meeting of the One Hundred and Thirty-seventh Session of the Society was held on Wednesday, the 19th November, when the Opening Address was delivered by the ATTORNEY-GENERAL, M.P., Chairman of the Council. The following arrangements have been made for the four meetings before Christmas :—

NOVEMBER 26.—FRANCIS GALTON, F.R.S., "Physical Tests in Competitive Examinations." SIR WILLIAM S. SAVORY, Bart., F.R.S., will preside.

DECEMBER 3.—JAMES DREDGE, "The Chicago Exhibition, 1893." THE ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

" 10.—F. BAILEY, "Electric Lighting Progress in London." SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

" 17.—GEORGE DAVISON, "Impressionism in Photography."

For meetings after Christmas :—

J. F. GREEN, "Steam Lifeboats."

WM. TOPLEY, F.R.S., "The Sources of Petroleum."

COLONEL SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S., "Methods and Processes of the Ordnance Survey."

F. J. RAVENSTEIN, "Lands available for Colonisation."

PROF. J. J. HUMMEL, "Fast and Fugitive Dyes."

A. G. GREEN, C. F. CROSS, and E. J. BEVAN, "Photography in Aniline Colours."

WILLIAM ROBINSON, "The Use of Petroleum in Prime Motors."

CARMICHAEL THOMAS, "Illustrated Journalism."

T. EMERSON DOWSON, "The Growing Need for Decimal Coinage, Weights, and Measures."

HEYWOOD SUMNER, "Sgraffito."

H. ARTHUR KENNEDY, "Glass Painting."

H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D., "Electricity in relation to the Human Body."

SIR ROPER LETHBRIDGE, M.P., "The Proposed Irish Channel Tunnel."

J. HARRISON CARTER, "Mining Machinery."

FOREIGN AND COLONIAL SECTION.

Tuesday Afternoons, at Half-past Four o'clock :—

January 20, February 17, March 17, April 21, May 5, 26.

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock :—

January 22, February 26, March 12, April 9, 30, May 28.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

January 27, February 10, March 10, 24, April 14, May 12.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

Professor VIVIAN B. LEWES, "Gaseous Illuminants." Five lectures.

LECTURE I.—NOVEMBER 24.—*Introduction*—Flame—The causes of luminosity in flame—The researches of Sir Humphrey Davy, Frankland, Solet, Stein, Hilgard, Blochman, and Heumann on the luminosity of flame—The effect of temperature, density and composition on the illuminating power of gaseous flames.

LECTURE II.—DECEMBER 1.—The composition of coal gas—Analysis of gas—The illuminants present in coal gas—Effect of class of coal, methods of manufacture, and diluents present, on the illuminating power of coal gas—The methods employed to enrich coal gas.

LECTURE III.—DECEMBER 8.—Carburetted coal gas—(a) By volatile hydro-carbons. The alko-carbon and Maxim-Clark processes—(b) By utilising those constituents of tar which can be converted by heat into permanent gases—The Dinsmore process—(c) By oil gas—The Tatham gas.

LECTURE IV.—DECEMBER 15.—The enrichment of coal gas by highly carburetted water gas—The Springer, Lowe, Meeze, Flannery, Stapp, Loomis, and Van Steenberg processes—Studies in carburetted water gas.

LECTURE V.—DECEMBER 22.—The products of combustion of coal gas when used as an illuminant and as a fuel—Various types of burner—Ventilating burners—Gas as a fuel—The products of checked combustion—Researches into the products of combustion of atmospheric burners under various conditions—The probable future of gaseous illuminants and heating gases.

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

January 26, February 2, 9.

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

February 16, 23, March 2.

Professor R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

March 9, 16, 23.

HUGH STANNUS, "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27.; May 4.

JUVENILE LECTURES.

Wednesday Evenings, at Seven o'clock, December 31, 1890, and January 7, 1891, E. B. POULTON, M.A., "Mimicry in Animals."

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, of Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886 for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of two or more Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Political and Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled:—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admissions to all Exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Courtts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary*.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1890-91. It is issued subject to any necessary alterations:—

NOVEMBER, 1890.			DECEMBER, 1890.			JANUARY, 1891.			FEBRUARY, 1891.		
1 S			1 M	Cantor Lecture I. 2		1 Th			1 S	Cantor Lecture II. 2	
2 S			2 Tu			2 F			2 M		
3 S			3 W	Ordinary Meeting		3 S			3 Tu	Ordinary Meeting	
4 Tu			4 Th			4 S			4 W		
5 F			5 F			5 M			5 Th		
6 F			6 S			6 Tu	Juvenile Lecture 2		6 F		
7 F			7 S			7 W			7 S		
8 S			8 M	Cantor Lecture I. 3		8 Th			8 S		
9 S			9 Tu			9 F			9 M	Cantor Lecture II. 3	
10 S			10 W	Ordinary Meeting		10 S			10 Tu	Applied Art Section	
11 Tu			11 Th			11 S			11 W	Ordinary Meeting	
12 Tu			12 F			12 M			12 Th		
13 Th			13 S			13 Tu			13 F		
14 F			14 S			14 W	Ordinary Meeting		14 S		
15 F			15 M	Cantor Lecture I. 4		15 Th			15 S		
16 S			16 Tu			16 F			16 M	Cantor Lecture III. 1	
17 S			17 W	Ordinary Meeting		17 S			17 Tu	For. & Col. Section	
18 Tu			18 Th			18 S			18 W	Ordinary Meeting	
19 W	Ordinary Meeting	(Opening Meeting of the Session)	19 F			19 M			19 Th		
20 Th			20 S			20 Tu	For. & Col. Section		20 F		
21 F			21 S	Cantor Lecture I. 5		21 W	Ordinary Meeting		21 S		
22 F			22 M			22 Th	Indian Section		22 S	Cantor Lecture III. 2	
23 S			23 Tu			23 F			23 M		
24 S	Cantor Lecture I. 1		24 W			24 S			24 Tu		
25 M			25 Th	CHRISTMAS DAY		25 S			25 W	Ordinary Meeting	
26 W	Ordinary Meeting		26 F	Bank Holiday		26 M	Cantor Lecture II. 1		26 Th	Indian Section	
27 Th			27 S			27 Tu	Applied Art Section		27 F		
28 F			28 S			28 W	Ordinary Meeting		28 S		
29 S			29 M			29 Th					
30 S			30 Tu			30 F					
31 S			31 W	Juvenile Lecture 1		31 S					
MARCH, 1891.			APRIL, 1891.			MAY, 1891.			JUNE, 1891.		
1 S			1 W			1 F			1 M		
2 S			2 Th			2 S			2 Tu		
3 Tu	Cantor Lecture III. 3		3 F			3 S			3 W		
4 Tu	Ordinary Meeting		4 S			4 M	Cantor Lecture V. 4		4 Th		
5 Th			5 S			5 Tu	For. & Col. Section		5 F		
6 F			6 M			6 W	Ordinary Meeting		6 S		
7 S			7 Tu			7 Th			7 M		
8 S			8 W	Ordinary Meeting		8 F			8 Tu		
9 M	Cantor Lecture IV. 1		9 Th	Indian Section		9 S			9 W		
10 Tu	Applied Art Section		10 F			10 S			10 Th		
11 W	Ordinary Meeting		11 S			11 M			11 F		
12 Th	Indian Section		12 Tu			12 Tu	Applied Art Section		12 S		
13 F			13 W	Cantor Lecture V. 1		13 Th	Ordinary Meeting		13 S		
14 S			14 Tu	Applied Art Section		14 F			14 M		
15 S			15 W	Ordinary Meeting		15 S			15 Tu		
16 M	Cantor Lecture IV. 2		16 Th			16 S			16 W	Conversazione	
17 Tu	For. & Col. Section		17 F			17 S	WHIT SUNDAY		17 Th		
18 Th	Ordinary Meeting		18 S			18 M	Bank Holiday		18 F		
19 F			19 M			19 Tu			19 S		
20 S			20 Tu	Cantor Lecture V. 2		20 W	Ordinary Meeting		20 M		
21 S			21 W	For. & Col. Section		21 Th			21 S		
22 S			22 Th	Ordinary Meeting		22 S			22 M		
23 M	Cantor Lecture IV. 3		23 F			23 S			23 Tu		
24 Tu	Applied Art Section		24 S			24 M			24 W	Annual General Meeting	
25 W			25 M			25 Tu			25 Th		
26 Th			26 S			26 W	For. & Col. Section		26 F		
27 F	GOOD FRIDAY		27 M	Cantor Lecture V. 3		27 Th	Ordinary Meeting		27 S		
28 S			28 Tu			28 F	Indian Section		28 M		
29 S	EASTER SUNDAY		29 W	Ordinary Meeting		29 S			29 Tu		
30 M	Bank Holiday		30 Th	Indian Section		30 S					
31 Tu						31 S					

The chair will be taken at Eight o'clock at each of the Ordinary Meetings, the Cantor Lectures, and the Meetings of the Applied Art Section.

The Meetings of the Indian and the Foreign and Colonial Sections will commence at Half-past Four o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Seven o'clock.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday evening, November 19, 1890, the ATTORNEY-GENERAL (Sir Richard Webster, M.P.), Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society :—

Angell, Col. John Charles, 12, Bolton-gardens West, S.W.
 Asch, William, Albert-mansions, 118, Victoria-street, S.W.
 Aukland, Thomas Frederick, Loxley-house, 85, Cazenove-road, Stamford-hill, N.
 Barrow, John, Beechfield, Folly-lane, Swinton, near Manchester.
 Benest, Henry, 15, Campbell-road, Bow, E.
 Binnie, Alexander R., 14, Campden-hill-gardens, W.
 Blackwell, Samuel J., Brookshill, Harrow Weald, Stanmore.
 Briggs, William, Burlington-house, Cambridge.
 Cameron, H. H. Hay, 70, Mortimer-street, W.
 Carew-Smyth, Ponsonby M., 30, Moor-park-road, Walham-green, S.W.
 Carr, Herbert Wildon, 34, Craven-street, Strand, W.C.
 Casson, James Hamilton, 26, Old Broad-street, E.C.
 Cheek, Philip, Baltic-wharf, Waterloo-bridge, S.E., and Henley-lodge, Mount Ararat, Richmond, Surrey.
 Cheesewright, Frederick Henry, 23, Gower-street, Bedford-square, W.C.
 Churcher, George, Bridgemary-house, Fareham.
 Coles, Samuel Hood Cowper, Pennegarth, Crickhowell, South Wales.
 Cooper, John Nealor, 5, Fairthorn-road, Charlton, Kent.
 Crowley, Philip, Waddon-house, Croydon.
 Dent, Admiral Charles Brayley C., Bryn-y-Mor, Holyhead.
 Dowker, George, Stourmouth, Wingham, near Dover.
 Ekin, Tom., 12, Little Queen-street, Westminster, S.W.
 Fox, Thomas, jun., The Court, Wellington, Somerset.
 Glasier, William Richard Minter, 3, The Paragon, Blackheath, S.E.
 Grant, Henry Sydney Hyrst, Chichester-road, East Croydon.
 Gray, C. H., Lessness-park, Abbey Wood, Kent.
 Gray, William Ernest, India rubber and Telegraph Works Co., Silvertown, E.
 Griffiths, William, Groby, Woodberry Down, N., and 283, Kingsland-road, E.

Harman, Alfred Hugh, Langsett, Ilford, Essex.
 Hatfield, Henry, H.M. Patent-office, Southampton-buildings, W.C.
 Hawliczek, Josef, 99, Ullet-road, Seftonpark, Liverpool.
 Hollyer, Frederick, 9, Pembroke-sq., Kensington, W.
 Hooker, Benjamin, Pear Tree-court, Farringdon-road, E.C.
 Hooper, Cecil H., Pains-hill-park, Cobham, Surrey.
 Hooper, Clarence, Exeter-hall, Strand, W.C.
 Houghton, William, Hoe-st., Walthamstow, Essex.
 Ievers, George M., Inchera, Glanmire, Co. Cork.
 Isgar, A. I., Racquet Foundry, St. Bride-street, E.C.
 Jefferiss, Arthur Henry, Claverton, Eliot-bank, Forest hill, S.E.
 Johnson, Sir John Henry, 23, Billiter-street, E.C.
 Jolliffe, Charles Henry, The Brewery, St. Helens, Lancashire.
 Jones, T. Hankins, Kenilworth, King's-road, Kingston-on-Thames.
 Kitto, Thomas Collingwood, Bedford-villa, 20, Marlborough-road, Gunnersbury.
 Laing, Charles Coleman, 16, Kensington-gore, S.W.
 Laing, John, Stanstead-park, Forest-hill, S.E.
 Lane, Col. Ronald B., 4, Savile-row, W.
 Mannesmann, Charles, Landore, Glamorganshire.
 Marks, Harry H., Londoun-hall, N.W.
 Marson, James, J.P., Hill-cliffe, near Warrington.
 Martin, Nicholas Henry, 85, Osborne-road, New-castle-on-Tyne.
 Maw, W. H., 35, Bedford-street, Strand, W.C.
 Merton, Zachary, 18, Chesham-place, S.W.
 Milne, Admiral Sir Alexander, Bart., G.C.B., 1, Lowndes-street, S.W.
 Mitchell, A. C., Lubbock-road, Chislehurst, Kent, and 44, Cannon-street, E.C.
 Orchard, John, 100, High-street, Kensington, W., and 27, Hereford-road, Bayswater, W.
 Paine, Charles Cleverly, Cedar-house, 124, Stamford-hill, N.
 Palmer, George William, Elmhurst, Reading.
 Peirce, William George, Riverside, Richmond, Surrey.
 Pochin, Percival Gerard, 13, Ranmoor-park, Sheffield.
 Price, Hall Rokeby, 1, Cowper's-court, Cornhill, E.C., and Hatfield-road, St. Albans.
 Rees, Rev. Samuel David, St. George's Vicarage, Pendleton, Manchester.
 Rew, R. Henry, Norfolk-house, Norfolk-street, Strand, W.C.
 Richardson, William James, Racquet Foundry, St. Bride-street, E.C.
 Roberts, William James, Regent-road, Lowestoft.
 Sax, Alfred Louis, 7, Ridgmount-street, W.C.
 Sax, Charles, 7, Ridgmount-street, W.C.
 Shaw, James Charles, 35, Leinster-gardens, Hyde-park, W.
 Smith, Major-Gen. Philip, 4, Hobart-place, Eaton-square, S.W.
 Soll, Jorgen Henrich Ferdinand, 204, Croydon-road, Anerley, S.E.

Somerville, Charles Stuart, 287, Broadway, New York.

Squire, Henry, 38a, King William-street, E.C., and Heath-view, Hampstead, N.W.

Stock, Collard Joseph, care of Bradbury, Wilkinson & Co., 25, Farringdon-road, E.C., and Junior Athenæum Club, S.W.

Stokes, Lieut.-General Sir John, K.C.B., Good Rest, Hayward's-heath.

Sutcliffe, Frederick William, 248, Rochdale-road, Oldham.

Sutton, Henry, 1 Farrar's-buildings, Temple, E.C.

Thomson, David Croal, 116 & 117, New Bond-street, W.

Thorne, Frederick G., Burntwood-lodge, Wandsworth-common, S.W.

Tiarks, Henry F., Foxbury, Chislehurst, Kent.

Toope, Charles, Stepney-square, High-street, Stepney, E.

Towle, William, 52, Fitzjohn's-avenue, Hampstead, N.W.

Townsend, E. de Kay, 300, Second-street, Baltimore, Ma., U.S.A.

Tyler, Rev. William, D.D., Pine-house, Holloway, N.

Vezey, John Jewell, 55, Lewisham High-road, S.E.

Willis, William, 49, Palace-grove, Bromley, Kent.

Wills, John, 16, Onslow-crescent, South Kensington, S.W.

Wilson, Arthur P., 12, Barkston-mansions, South Kensington, S.W.

Wood, Collingwood Lindsay, Freeland, Forgan-denny, N.B.

Wratten, Frederick Charles Luther, 38, Great Queen-street, Long-acre, W.C.

Young, Maj.-Gen. Charles Becher, 7, Bath-road, Bedford-park, Chiswick.

The CHAIRMAN delivered the following

ADDRESS.

In undertaking the duties of Chairman of the Council of this Society, I have felt more than diffidence and doubt as to whether I was justified in assuming so responsible a position. When I remembered the great men who have filled this place in the past, I could not but hesitate before accepting so high an honour; but there are personal reasons which added to the hesitation induced by the considerations already mentioned. To one whose duty and work has been principally to re-arrange and formulate the ideas of other people, it is a difficult, nay, an impossible task, to attempt to represent, in any way worthy of this Society, any branch of scientific or artistic research; and I have no qualification derived from personal scientific knowledge which would justify me in intruding upon the

notice of the members any original ideas of my own; but an almost passionate admiration for the results of original thought and work have inspired in me the great desire to appreciate from time to time what others are doing, and, as far as a busy man can, to keep myself in touch with the work of this Society. I moreover recognise that it is the duty of anyone who has been honoured by election to the Council of such a Society as this to place his services so far as he properly can at the disposal of its members, in order to further the best interests of the Society. It is with this feeling and with the earnest hope, though I may not say expectation, that I may be of some small service to the Society during my two years of office, that I have ventured to undertake the duties of the position I now hold.

Since I received notice of my election, I have bestowed a great deal of thought upon the question as to the subject which I might be fitted to introduce as the main topic of my address, and it occurred to me that it would not be out of place to consider at this period, and at the commencement of another session, the functions of the Society of Arts in relation to Invention. That subject naturally divides itself into two main branches, the one historical and the other initiative. It is to the historical branch of the subject that I propose to-night mainly to direct your attention, although if time be spared to me I may attempt to make a few observations upon the initiative.

I need not remind my present audience that the Society has existed for 136 years. During 107 years of that period it has maintained through its *Transactions* and its *Journal* a continuous and contemporary record of the labours, researches, hopes, and aspirations of scientific men. To the man of leisure, few more interesting, useful, and fascinating tasks could be set than to trace out through the pages of such a record the history of the development of invention. He would be struck by the foresight of great minds, by prophecies verified, or rather justified by subsequent events. He would find repeatedly the statements as to the supposed finality of a particular achievement subsequently shown to be merely the threshold of the passage to future discoveries, or the first stepping stone of a track previously unexplored, and sometimes unobserved; nay, more, I remember more than one instance in which there has been written up, as it were, by the hand of earlier writers, with apparent confidence, a notice—

"no road this way;" and yet by the labours of fresh mind, going over the same district, the notice has been taken down, the ground re-explored, and the path to success actually discovered. One aspect of the case which has struck me not unfrequently, and would undoubtedly occur to the mind of any person examining the subject from the point of view which I am suggesting, has in it an element of sadness; I mean the frequency with which lives have been spent, fortunes, if not sacrificed, at least bestowed, and sometimes lost in the pursuit of an end which was undoubtedly capable of being attained; and as to which, with the light of subsequent knowledge it is difficult to understand why the labours of those who had previously investigated the matter were doomed to failure instead of being crowned with success.

Many have failed after years of labour, and it has remained to the more fortunate in later years, and not unfrequently by making use of the researches of those who have gone before, to achieve the success which was almost in the grasp of their less fortunate predecessors. Instance after instance might be given. It required the labours of a Mushet; to enhance the victories of a Bessemer; it demanded the sacrifices of a Gossage to bring out, in clear relief, the achievements of Chance and Rawes.

When I first formulated, in my own mind, the theme or brief outline of this address, I had no conception of the mines of wealth as to the history of invention, and scientific research which lay stored up—to many, I fear, entombed—in the pages of the *Journal* of the Society. I owe much to the assistance of our excellent and indefatigable Secretary, Sir Henry Trueman Wood, who has entered into the spirit of my wishes with great energy; and, from his researches, supplemented by my own, and by those of another friend, to whom I also owe a debt of gratitude—I mean Mr. Ernest Carmel—I have collected materials sufficient to occupy three or four times the time during which I feel justified in trespassing on your attention, from which I could point out how the history of most of the leading achievements or departures in science and art have been recorded in the transactions of this Society. In this hall and from this place have spoken many men whose ideas were considered as vain, fanciful, and almost chimerical, whose predictions were regarded as the dreams of the theorist, or the illusions of the idealist, and

yet years after sometimes the same men, more frequently, alas, their successors, have heard from the same place the realisation of many an idea—the fulfilment of many a prophecy.

I will enumerate some only of the subjects which have come or have been brought to my notice, in the first instance contenting myself with mere enumeration, subsequently directing your attention at greater length to three striking instances.

Improvements in the manufacture of iron and steel.

The utilisation of alkali waste.

The development of the electric telegraph.

The telephone and phonograph.

The invention of the gas-engine.

Improvements in photography.

Transmission of power by electricity.

The utilisation of silk waste.

The preservation of food by cold.

The use of electricity for welding.

The development of electric light.

Inventions in connection with the machinery for producing textile fibre.

The compounding of the locomotive engine.

These occur to me, and numbers of others could be added.

From the above list I desire to select one or two instances, varied in character, to illustrate and enforce the general observations which I have already made. I will choose one which at the present time is engaging a great deal of attention, and likely to increase in popular usefulness—I mean photography. The progress of photography can be traced step by step in the records of the Society of Arts. The year 1839 was signalised by the discoveries of Daguerre, viz., that a highly-polished silver plate could be rendered sufficiently sensitive to the effect of light to retain the image or impression refracted upon it. In 1847, we find M. Claudet reading a paper on the daguerreotype process before the Society. He had then recently propounded the theory, which later researches in connection with electricity are thought by some to go far to verify, that the principal agent in photography was an emanation from the sun, something which is not light, nor yet heat, and he had to admit that the most skilful operator was only an empiric who obtained his results without knowing their cause. M. Claudet seemed to have arrived at the conclusion that no increase in the rapidity of photographic processes was required, and that if we could find a substance which permitted an exposure of half the time—I may mention that a daguerreotype portrait could

then be taken in about twenty seconds—it would be desirable to use a lens which would operate with half the speed. As a matter of fact he was not very far wrong, having regard to the conditions under which he was working.

Later on in the year 1852 Roger Fenton read a paper shortly after the Society had held its first exhibition of photographs (which exhibition, I may note, resulted in the formation of the Photographic Society), and in that paper Fenton spoke of the collodion negative as the *ne plus ultra* of photographic excellence. The application of this phrase to a process which is now, to a large extent at least, obsolete, shows how slow we should be to apply such a term to any known scientific process. Though Mr. Fenton seemed to be satisfied with what we should now consider the very limited power then placed at the command of the photographer, he had a sufficiently clear notion of what might be done in the future. He suggested the application of photography to astronomy—an interesting prophecy, now that the heavens are being so elaborately mapped by photographic means—and to the microscope, and he quoted as an instance of the application of photography to scientific and geographical research the fact that photographic apparatus had been supplied to the Arctic expedition under Sir Edward Belcher, and to another exploring expedition sent into the South Pacific under Captain Denham. In the following year, 1853, Mr. Kingsley described before the Society a method of photographing microscopic objects on a large scale, which, though considered at the time a great development, would now be regarded both as clumsy and inefficient. From that time down to the present, we have had continual reference to the progress of photography, and descriptions of its various applications, until of late years we find its present condition admirably described in the papers and lectures given by Captain Abney, Mr. Bolas, Mr. Burton, Mr. Spiller, and others.

Nor is it to pure photography, apart from its applications, that this observation applies. The first practical method of producing a printing block by photographic means, Pretsch's process of photogalvanography, was described here by the inventor in 1865, and in 1869 Mr. Davenport predicted that at no remote period engraving, like miniature painting, would, owing to the progress of photography, become practically obsolete. If this prediction has not been realised as regards engraving proper, it has very nearly been fulfilled as regards wood

engraving; which has been seriously affected as a profession by the various photographic processes on which illustrated journalism is now so largely dependent. We shall look forward with much pleasure to the latest information on this subject in the paper promised us by Mr. Carmichael Thomas on "Illustrated Journalism."

Few speculations possess more interest than that of the probability of our succeeding in the production of photographic pictures in their true or local colours. For more than half a century this problem has engaged the attention of many experimenters, although originally pronounced to be an illusion by so great an authority as M. Biot. In February, 1840, Sir John Herschel succeeded in procuring upon photographic paper a coloured image of the solar spectrum, and he regarded this result as bringing near the hope that coloured photographs might be obtained. In 1857, Robert Hunt, the well-known pioneer in scientific photography, detailed various experiments in which he had obtained pictures of the spectrum by means of daguerreotype tablets, prepared in a peculiar way with iodine, on which he stated that the colours had softness and brilliancy. Daguerre himself had remarked that, when he had been taking the picture of any red-brick or any painted building, the photograph assumed a tint of that character. From these facts Robert Hunt expressed the opinion that the possibility of our being able to produce coloured photographs was decided—the probability brought infinitely nearer; and he alludes in the same publication to some experiments of M. Niepce de St. Victor, which when first produced, were alleged to be perfectly coloured. I am not sufficiently in the secrets of those who have recently been in active pursuit of the same object to express any opinion as to whether or not these hopes are much nearer fulfilment, but if rumour be correct, we shall, before long, have an announcement of great progress in the same direction; and I trust that the members of the Society of Arts will have an opportunity of themselves judging of the processes by which those results have been achieved.

It is, moreover, interesting to note that the subsequent theories of Clerk Maxwell with regard to electricity, and the experiments of Professor Oliver Lodge and Sir Archibald Campbell, may verify the somewhat crude suggestions of M. Claudet as to the real agency which operates in producing a photographic image.

I select now, from my list already given, another instance of an entirely different class, but as showing clearly the connection between the history of inventions and the work of this Society in a matter connected with commerce. I refer to the marvellous development in the industry of the preservation of food by cold. In 1866, the Council appointed a committee, which investigated matters connected with the preservation and supply of food; and that committee examined a great number of processes and specimens. At that time little was hoped from the use of refrigerating or cold processes, although it was well known, as a scientific fact, that meat could be preserved in this way for an indefinite time. The discovery of entire carcasses in the ice-cliffs of Northern Siberia, with the flesh, skin, and hair upon them, in the frozen soil, in a state of perfect preservation, established this beyond all question. In the year 1869, the problem of bringing frozen meat from Australia was brought prominently before the Society. Mr. Mort had, at that time, been spending large amounts in Sydney in experimenting on the freezing of meat by Reece's ammonia machine. There was at that time no difficulty in freezing the meat, but the difficulty lay in bringing it when frozen across the tropics, and keeping the machine at work during the whole process. Mr. Mort and Mr. Reece were then confident as to the soundness of the principle of their invention, as was stated by their representative before the committee of this Society. The machine itself was described in a paper read by Dr. Paul in December, 1868, when the chairman, Mr. Seymour Teulon, expressed great hopes as to the practicability of bringing large supplies of meat from Australia and South America, and enlarged with great force on the importance of the industry. None, however, of the ammonia process machines proved practically efficient for the purposes desired, and it was not until the year 1879, when the Bell-Coleman machine was introduced, that the problem of keeping carcasses sufficiently cold to preserve them during long voyages through the tropics was practically solved, and a commercial enterprise of enormous magnitude was started. An excellent paper in connection with this matter was read before this Society by Dr. Hopkinson in the month of November, 1882.

This subject is exceedingly interesting, because we can see from our present knowledge the exceedingly small step of invention that was necessary in order to render successful

that which had previously been a failure. The difficulty was the getting rid of the water vapour constantly given off from the meat, even in its frozen state. Twenty years before, Dr. Gorrie had made machines in which air was compressed in one cylinder, cooled whilst in a state of compression, and re-expanded in another cylinder doing work. Before the year 1857, Sir William Thomson had suggested a similar arrangement for cooling apartments, and Professor Rankine and Professor Piazzi Smyth had actually constructed apartments so cooled, whilst the same principle had been embodied in apparatus described by Windhausen in the year 1869. Notwithstanding these facts, a period of more than twenty years elapsed, from 1857, before the practical difficulty was overcome. It is impossible for me here to give detailed statistics of the growth of this industry, but I may mention that in the year 1889, as I gather from figures furnished by the Mayor of Derby, upwards of 195,000,000 lbs. of beef and mutton were imported into England from various parts of the world, and in the first nine months of the year 1890 upwards of 187,000,000, or an average for the year of 250,000,000 lbs. Having regard to the present condition of population in the United Kingdom, it is not possible to exaggerate the importance of such an industry.

Time permits me to relate one other instance, and one other only, from my list, but it is one which brings out in the clearest relief what has been the value to the scientific historian of the work of the Society. I refer to the progress of electricity. Prior to the establishment, in the year 1871, of the Society of Telegraph Engineers, incorporated as the Society of Electrical Engineers in the year 1883, there was practically no place where the remarkable developments in electricity were from time to time recorded, except in the Transactions of the Society of Arts. We may go back to 1823, when Sturgeon, the inventor of the electro-magnet, gave his first description of that apparatus in a paper which is still on record in the Society's Transactions. This may with great interest be compared with the paper of Mr. Thomas Allan on the subject of Electro-Magnetism as a Motive Power, read in the month of March, 1858, where will be found a very remarkable prophecy of Sir William Siemens as to the necessity of improved means of obtaining the electric current rather than mechanical contrivances for utilising it,

a necessity which was not fully met until the invention of the Gramme dynamo machine. Passing down to recent time, we have the paper by Dr. J. A. Fleming on the electro magnetic induction experiments of Professor Elihu Thompson, and the admirable lectures by Professor Silvanus Thompson on the electro-magnet. Contemporaneously, at intervals, during the period of which I have been speaking, there have been read papers on the Measurement of Electricity, on Electricity as a Motive Power, on Electric Locomotion, and on the Transmission of Power by Electricity, in which will be found most remarkable expressions by members of the Society as to the probable development of the use of electricity in these directions, one of which has received a striking fulfilment, during the last few days, in the opening of the Southwark and City of London Electric Railway by our President, His Royal Highness the Prince of Wales. Then, again, the development of electric lighting, the improved construction of lamps, the possibility of the employment of primary batteries, the construction of the dynamo machine itself have, during the last few years, been subjects to which the attention of the members of the Society have been directed by papers of the greatest interest. And although, as I have already pointed out, it may be that in years to come these subjects will receive closer and more thorough attention from the Institution of Electrical Engineers, I am quite sure that the information stored up in the papers to which I have made but a passing reference, will be found of the highest value to those who desire to trace out what has been the line of thought which has led to such practical success in every branch of electrical energy. I have no doubt, from the papers which are already promised by Mr. Bailey, Mr. Kapp, and others, that the coming session will not fail to supply us with opportunities of extending our knowledge in the same direction.

From another branch of the work of the Society of Arts, illustrations of the greatest interest of that to which I have already been referring might be taken. I allude to the series of awards of the Albert Medal, established in 1864, in memory of H.R.H. the Prince Consort, who was for 18 years the President of this Society. It has been awarded to a number of distinguished men in succession, the value of whose services to science and art cannot be exaggerated. The names of Faraday, Sir Charles Wheatstone, Sir Henry Bessemer, Sir William Siemens, Sir William

Thomson, Professor Joule, M. Pasteur, and many others are to be found in the list. Hours might be delightfully spent in describing the labours of such men as those who received this medal.

From the list of Albert Medallists there is no name could better be chosen as an illustration of my subject than that of Sir William Siemens. I have myself heard from his lips, on more than one occasion, that he was induced to settle in this country and give to England the benefit of his gigantic intellect in consequence of the protection afforded to invention by the Patent-law of the United Kingdom. As early as the year 1858 he read a paper on the progress of the telegraph, and from time to time down to his address as Chairman of the Council in the year 1882, he took constant part in the proceedings of this Society, occupying the chair at meetings and taking part in the discussions. It will be remembered by many here how in the course of his address in the year 1882 he mentioned that as far back as 1877 he had pointed out the great practical future opened to current electricity by the then newly-invented dynamo of Messrs. Gramme, and called attention to the fact that his views, some of which already, and the great majority of which have since been realised, were regarded as being chimerical. It must be a great encouragement to us to remember that he, in acknowledging a vote of thanks accorded to him, recorded the fact that the Society of Arts was the first Society with which he became acquainted, and the first which recognised his labours by awarding him, in 1850, its gold medal for his regenerative condenser. To him was awarded, in 1874, the Albert Medal for his researches in connection with the laws of heat, and the practical application of them to furnaces used in the arts; for his improvements in the manufacture of iron, and generally for the services rendered by him in connection with the economisation of fuel and its various applications to manufactures and arts. Not many men such as Sir William Siemens appear in a generation, or even in a century; but it is a great incentive to those who are interested in the Society's work to feel the Society may fairly claim to have been of service to him, and to have assisted in some degree in making more widely known the immense benefits conferred by him on science, and may hope that they may yet render like assistance to a Siemens in years to come.

I would also call attention to the important

work performed by the Society ever since the year 1863, through the means of the lectures known as the Cantor lectures, delivered under the Cantor bequest. These lectures, which have all been published, form as valuable a series of treatises on applied sciences and arts as exist, and the courses given last year were certainly up to the high standard which has been attained by previous lectures.

Of the papers read at Ordinary Meetings, I should have occasion to speak at a later stage of our present proceedings, and I therefore pass them by for the moment; but another branch of the Society's work requires special notice from me. I allude to the Examinations.

For thirty-four years the Society has been carrying out a system of examinations in commercial knowledge which, to some extent, fulfils the requirements which have been demanded by those who are interested in the promotion of commercial education. The attention which has recently been drawn to the subject has had a remarkable influence on the Society's examinations, as the number of candidates for the past year showed an increase of 33 per cent. over the year preceding, and this notwithstanding that recent additions in this direction have been made to the programme of the University Local Examinations. I submit to the members of the Society that the Society's work in this direction might be extended, so as to include, to a larger extent, pupils actually engaged at schools. At present, most of the candidates come from evening classes; and I invite suggestions during the coming Session with a view to extending and increasing the value and efficiency of these examinations.

I pass with regret from the historical aspect of my subject to make a few remarks upon the second branch which I have called initiative, by which I mean the functions and duties of the Society of Arts in connection with invention in the future.

The Society cannot carry out the objects for which it was founded—the promotion of Arts, Manufactures and Commerce—without being ready to adapt itself to constantly changing conditions. The method which was at first adopted, the giving of prizes and encouraging special inventions, was, at the middle of the last century, most valuable; but invention and science has got beyond the nursing stage, and these methods are practically obsolete. In place of encouraging individuals, the Society has, of late years, assisted in the reform of the Patent-laws, which provide inventors

with the protection they require. The official position I now hold makes it impossible for me to discuss possible amendments of the law. I have received many suggestions from kind friends, and at another time, and under other circumstances, I shall be only too glad to express freely my views as to the working of the Act of 1883. It is, however, well to remind the Society that in these rooms, and from a committee called together at the instance of the Society of Arts, first proceeded the suggestion of limited protection for exhibitors at the Great Exhibition of 1851, which subsequently developed into the Patent-law Amendment Act of 1852, establishing the extremely important principle of granting to all inventors a period of provisional protection. From time to time this Society opened its doors to discussion as to the working of the Patent-laws; allowed the opponents of those laws an opportunity of stating their arguments, and, at the same time, ventilated by discussion those defects in the administration of the Act of 1852, which called for amendment and remedy. Subsequently, in the year 1882, a strong committee was formed which had a great share in the passing of the Patent Act, 1883, which, whatever may be our opinion as to the sufficiency of its provisions or its defects, certainly remedied many of the evils of which complaint had been made. I have been present from my boyhood at many of these discussions, and have had the privilege of taking part in the work of the late committees, and I sincerely trust that the same watchful interest in the improvement of the Patent-laws, and the same care for the best protection for inventors and inventions will be evinced by the Society in the future as in the past. There are still among its members those who from personal experience as inventors, as experts, as patent agents, and as scientific men, are best able to guide public opinion upon these questions, and I have no doubt the subject will not be overlooked by the Council of the Society.

I cannot close these observations without referring to the losses sustained by the Society during the past twelve months by the death of several who have in various ways and at various times shown their interest in the Society's work. I would mention Lord Magheramorne and Canon Liddon, both conspicuous members of the Society, but in addition I must pay a tribute to the memory of Sir Edwin Chadwick, who laboured so long and so usefully in the cause of sanitary science, and

who has at various times expressed opinions in these rooms which have had the effect of directing men's minds and thoughts to existing evils, and to the remedies which improved knowledge and discussion could suggest for their removal. We mourn also the loss of Sir Richard Burton, the eminent traveller, whose papers here have received the acknowledgment of the Society's medals, and Mr. Alexander J. Ellis, F.R.S. whose knowledge in connection with the study of philology and music will be recognised by many old members. I cannot, moreover, pass by the name of Dr. John Percy, though his death, which happened in June, 1889, does not come within the limit of time to which these remarks should be restricted. It must be a matter of great gratification to members of this Society that but a few days before his death he had the honour of receiving the Albert Medal "for his achievements in promoting the arts, manufactures and commerce, and for the world-wide influence which his researches and writings have had on the progress of the science of metallurgy." No better summary of the value of his work could possibly be given, and it would be quite impossible within the limits of such an address to refer in detail to the value his services in those sciences with which his name has been so long connected.

I turn for one moment to a brighter topic. I allude to the honour of knighthood bestowed during this year by Her Most Gracious Majesty upon our secretary, Sir Henry Trueman Wood, a distinction worthily earned and fully merited by one who has for a long series of years devoted to the interests of the Society the fullest and most unremitting attention, and by his great public services in connection with many international and national exhibitions gained the esteem and earned the gratitude of every one with whom he has been brought into contact.

What shall be the future of this Society? It may be that the elaboration of particular sciences, or the development of particular industries, may call into existence in years to come, as they have in years gone by, separate independent agencies devoted to the advancement of special interests. This Society will gladly welcome in the future, as she has in the past, the birth of any such kindred associations, which can, by directing attention more closely to particular subjects, carry the work of the extension and diffusion of knowledge in the details of any particular art or science to a greater and more useful extent.

I may remind the members that from the action of this Society and from the exhibitions of pictures held in the years 1760 to 1764 grew the Royal Academy, founded in 1768. Here, nearly fifty years ago, was founded the Chemical Society, which has, I am glad to know, so outgrown the most sanguine expectations of its founders that I doubt whether these rooms will be sufficiently large to hold all those who would wish to be present and take part in its jubilee next year, gladly as we should welcome them here. I have already noticed how the Photographic Society sprang from an exhibition held under the auspices of the Society of Arts. We may fairly claim no inconsiderable share in the formation of that important institution, the City and Guilds of London Institute for Promoting Technical Education, to the active work of which eminent members of our Council have with the greatest self-sacrifice given large portion of their valuable time. The National Training School for Music, founded by the Society of Arts in 1878, has since, under the patronage of H.R.H. the Prince of Wales, developed into the Royal College of Music. The part which the Society played in the great exhibitions of 1851 and 1862, and in the subsequent series in the years 1883-87, is well-known. To the Imperial Institute, in which our Royal president so justly takes pride, the Society will offer all the assistance which her longer life and the experience of her members enable her to give, and will gladly welcome the opportunity for further progress in some of those branches of knowledge, which have hitherto received notice and support from this Society alone. But there will still be work enough, and more than enough to warrant increased zeal and energy on the part of members of the Society; and I trust, as long as the British nation exists, the proceedings of the Society of Arts may bring to public notice the labours and efforts of many who have striven to advance the greatest of all human pursuits—the diffusion of useful knowledge—and may be the means of giving a helping hand to the work of many a young inventor, previously unknown, and possibly struggling, almost in vain, to show that he has grappled successfully with difficulties and broken down barriers which have baffled the skill and defeated the efforts of those who have preceded him, and may form in the future as they have in the past an almost complete record of the march of science, the progress of art, and the spread of commerce.

I have now the pleasure, on behalf of the Society, of presenting the Society's Silver Medal for papers read during the last Session.

To Dr. Armand Ruffer, for his paper on "Rabies and its Prevention." It gives me great pleasure to present this medal to Dr. Ruffer. He was, for many years, connected with M. Pasteur; and I would remind the Society that, as far back as 1882, the Albert Medal was presented to M. Pasteur (and since that time the whole world has recognised the value of his labours) for his discoveries connected with the science of medicine. It is a great pleasure to have the opportunity of recognising the merits of one who has been so closely connected with him.

To Mr. Arthur Paget, for his paper on "High-speed Knitting and Weaving without Weft." Those who have had the opportunity of following this paper, and other publications by Mr. Paget, will be able to form a high opinion of his great ingenuity and constructive skill.

To Mr. Talbot B. Reed, for his paper on "Old and New-fashioned Typography." When it is remembered that Mr. Reed is the son of Sir Charles Reed, so long connected with the production and manufacture of the best kind of type, the Society will know that the information contained in his paper came from the most trustworthy sources, and well deserves recognition from the Society.

To William Whitaker, F.R.S., for his paper on "Coal in the South-East of England." I need not remind those present of the services rendered by Mr. Whitaker in connection with the geology of the chalk strata, and particularly their bearing on the London water supply. In his paper read before the Society he showed how geological researches were likely to result in the establishment of a new coal-field in England, and what great social and economic changes are likely to arise therefrom, a subject in which members of the Society interested in commerce must take the most lively interest.

To Dr. J. A. Fleming, for his paper on "Professor Elihu Thomson's Electro-Magnetic Induction Experiments." I have already called attention to this paper. I may remind members how valuable to electricians was his exposition of Professor Elihu Thomson's work.

To Mr. J. G. Gordon, for his paper on the "Mannesmann Process for making Seamless Tubes." There are several reasons why I feel pleasure in congratulating Mr. Gordon on the receipt of this medal. Connected with the family of Sir William Siemens, it will, I am sure,

afford him pleasure to receive the award; but in addition I would point out that the paper in respect of which the medal has been awarded was one of the most remarkable papers which has been for many years produced before the Society. I have been cautioned by eminent members of the Council against any attempt to summarise or describe the contents of that paper, and I will therefore simply refer to the notes of the discussion contained in the Society of Arts *Journal* of May 23, 1890. But I may add that no less authorities than Sir Frederick Bramwell and Professor Kennedy expressed the opinion that prior to the publication of the Mannesmann process it appeared the most hopeless problem for any man to set himself—to make seamless tubes out of a solid bar of metal. The paper was a model of clear exposition and lucid description, and deserves to be noticed as one of the most remarkable inventions ever brought before the Society.

I have now to present the medals in the Foreign and Colonial Section: one to Lieut.-General Sir John Stokes, for his paper on "The Danube and its Trade." It would occupy a great deal of time if I were to mention to the members present all the services of Sir John Stokes; but, associated as he has been with Sir Charles Hartley in the superintendence and improvement of the mouth of the Danube, and distinguished also for his services in Egypt and other parts of the world, the Society esteem it a great honour that he should have contributed so valuable a paper to their discussions.

To Mr. Lazenby Liberty, for his paper on "The Industrial Arts of Japan." In presenting this medal to Mr. Liberty, I venture to remind members that he has brought to bear on the question of the artistic treatment of furniture and decoration an experience surpassed by few, gathered from personal study of the subject.

To Mr. Frederick C. Danvers, for his paper on "The Records of the India-office." Those acquainted with the history and government of India, and of the extreme importance of statistical information, are well able to appreciate how great has been the services of Mr. Danvers in reducing to a system the masses of information in the hands of the India-office.

To Sir Theodore C. Hope, K.C.S.I., C.I.E., for his paper on "The Rationale of Indian Railways." Anglo-Indians remember well the services rendered by Sir Theodore Hope, as head of the Indian Railway Department; and

at this time, when the question of feeder lines, small narrow-gauge railways, and other improved means of communication with the commerce of India is prominently before the public, his paper will be found to be of great value.

To James Orrock, R.I., for his paper on "The Claims of the British School of Painting to a thorough representation in the National Gallery." Himself a water-colour artist of no mean repute, Mr. Orrock has always displayed a lively interest in the promotion of British art; and the establishment of a national gallery of British art is an object to which many years ago the Society devoted a great deal of attention. I trust that the movement will receive a considerable impetus from the valuable paper contributed by Mr. Orrock.

To Professor W. Chandler Roberts-Austen, C.B., F.R.S., for his paper on "The Use of Alloys in Art Metal Work." Great as have been the services of Professor Chandler Roberts-Austen, it may be said of his recent researches and experiments that he has opened out a new field altogether, in connection with the use and effect of small quantities of alloy upon other metals. It is not the first time that the Society of Arts has been under an obligation to him, and I am sure the members present will be glad that he should receive this acknowledgement.

The Chairman then presented the Society's Bronze Medal to the following candidates, who obtained the maximum number of marks at the Society's Practical Examination in Music in June:—

PIANOFORTE PLAYING.

Miss Florence Emma Batty.
Miss Emily Free.
Miss Alice Esther Grouse.
Miss Emilie L. Hawkins.
Miss Nellie Hoe.
Miss Annie E. Holdom.
Miss Alma Martha Kessler.
Miss Mary Georgina Knight.
Miss Maud Lilian Nichols.
Miss Susie Myra Pye.
Miss Ida Thompson.
Miss Alice Emma Wallis.
Miss Emily Watling.

SINGING.

Miss Ellen Theodora Bagnall.
Miss Maud Boniwell.
Miss Elizabeth Ada Burman.
Miss Lydia Hale Lawrence.

ORGAN PLAYING.

Mr. B. Jackson, F.C.O.

Sir FREDERICK BRAMWELL, Bart., F.R.S., said he was sure the meeting could not separate without awarding the acknowledgments of the Society to Sir Richard Webster for taking the chair that evening; and not only that, but for undertaking the office of Chairman of Council for the ensuing year. It was now some time since Sir Richard joined the Council, and, though they all knew what his engagements and occupations were, there had never been an occasion when his special knowledge was required, but he had made time to attend. He had been always at the services of the Council for advice, and ready to give the benefit of his enormous knowledge. It was a great satisfaction to the Council to find that he was willing to take upon himself the onerous duties of chairman, and it was certain that he would carry them out, no matter at what sacrifice to himself. He had given a satisfactory account of the Society during the period—over a century and a quarter—that it had been in existence, of the good work it had done, and how it had fostered good work in others. The way to continue such good work so as to merit the applause of a future generation, would be to take care, on all accounts, to be represented by a Chairman of Council competent to watch over and preserve the interests of the Society, and having its interests thoroughly and truly at heart. Sir Richard Webster was, of all men, most competent to fulfil those duties, and he begged to propose a most hearty vote of thanks to him, both for his services that evening and as Chairman of Council.

Lord THURLOW, in seconding the vote of thanks, said they were all aware of the distinguished position occupied by Sir Richard Webster, not only in politics but in science and the world at large, and that an honour had been conferred on the Society by his accepting the office of Chairman of Council. They would also recognize in him one who had for years past done an immense deal in advancing one of the great sciences of the age—he referred to electrical science in all its branches.

The vote of thanks having been carried unanimously,

Sir RICHARD WEBSTER, in reply, after thanking Sir Frederick Bramwell and Lord Thurlow for the kind feeling they had expressed, said it would naturally be impossible for him to promise that he could give the same amount of time to the work of the Society of Arts as others who were closely connected with scientific work would be able to do, but still he did trust that in some ways, though from a different standpoint, he might be able to be of service. It was a great privilege to be elected a member of the Council and

to be brought into close association and intimacy, and have the opportunity of constantly meeting with men who had been for many years foremost in their respective professions, and who had shown both by their writings and speeches what they had been able to do for those arts and sciences with which they were engaged. It was an immense advantage to anyone in his position as a lawyer to have the opportunity of coming into personal intercourse with such men. He would endorse by a personal appeal what Sir Frederick Bramwell had said, and to express the hope that the members of the Society would not allow its reputation to suffer for want of taking trouble in the future. As he had already said, the work of the Society did require to adapt itself to changing conditions, but they would all regret if having succeeded so well in years gone by, it should, through any want of effort on the part of the present members, fail in maintaining, or even improving, the reputation which attached to it for its past work.

Miscellaneous.

BARLEY CULTURE IN FRANCE.

The large consumption of beer by European nations gives to the cultivation of barley a special interest, to which the attention of the French agriculturists appears at present to be particularly directed. The cultivation of this crop, which can be grown between extreme geographical limits, will always be important, as it is an article of food for men and beasts, and is also employed not only in the manufacture of beer but in that of alcohol. M. Tisserand, the chief of the French Bureau of Agriculture, has recently published in the *Bulletin d'Agriculture* an article showing that the culture of this grain will be one of the most profitable that can be grown in France. Especial attention is called to chalky and calcareous soil, where other grain is cultivated with difficulty, but where barley can be grown to great advantage. The total production of barley in the world is estimated at 825,000,000 bushels. Of this amount Europe produces from 630,000,000 to 650,000,000 bushels, valued at £160,000,000 sterling. The following will show the average production for each country:—Algeria, 60,500,000 bushels; Austria Hungary, 88,500,000; Belgium, 3,665,700; Bulgaria, 15,125,000; Canada, 19,250,000; Denmark, 20,650,000; Egypt, 27,500,000; England, 90,750,000; France, 49,500,000; Germany, 93,500,000; Holland, 4,400,000; Norway and Sweden, 22,000,000; Roumania, 19,250,000; Russia, 129,250,000; Spain, 77,000,000; Turkey, 13,750,000; and the United States, 57,750,000 bushels. In reviewing the past

forty years, says the United States commercial agent at Limoges, it is to be noted that France, instead of increasing the area sown with barley, has rather decreased it; but the amount raised per hectare has increased, showing a better cultivation. In 1850 there were 2,934,360 acres sown with barley; in 1862 the area was only 2,684,890, while in 1882 only 2,457,650 acres; and this was reduced in 1886 to 2,338,349 acres. It must, however, be remembered that 247,000 acres of barley in Alsace and Lorraine were lost to French soil. The average annual yield in France for the decade 1876-86 was exactly the same as that of 1834-44—about 50,600,000 bushels, but the return per acre has greatly increased since then. From 1830 to 1835 the yield was 15.50 bushels per acre, from 1852 to 1857 it was 18.15, and from 1877 to 1886 it had risen to 19.91 bushels per acre. The countries which have increased their areas under barley are England, Germany, Denmark, Austria, and the United States. Looking at the prices of barley during the last twenty years, it will be found that there has not been much encouragement to cultivate this cereal. In the period from 1871 to 1878 the average price per bushel was 3s. 10d.; it fell to 3s. 5d. from 1879 to 1886. French Custom-house returns show that the importations have increased during the past twenty years, and the exports have experienced a considerable reduction. The average annual increase of imports from 1878 to 1887 was 1,066,430 cwts., valued at £400,000. During the same period the exports diminished on an average 1,001,769 cwts., valued at £360,000, showing an annual deficit of between £720,000 and £760,000. M. Tisserand says:—"Why does not France, with land so eminently adapted to the cultivation of barley, devote more attention to this grain?" and he answers the question in the following manner:—"Barley gives but little straw, and for a long time the price of this grain scarcely exceeded half that of wheat; finally but little beer was made in France. For these three reasons French farmers have neglected barley, and given all their attention to wheat. They preferred to abandon the cultivation of the former cereal because it was not so remunerative. At the present day, however, the situation is changed under the influence of increased demands made for this grain." The present price of ordinary barley is from 70 to 76 per cent. of that of wheat. Prime barley, which is sold to the brewers, commands almost the same price as wheat. All things being equal (care, labour, manure, &c.), the yield of barley per hectare (2.47 acres) surpasses on an average that of wheat by one-third. In order to obtain the advantage of this increased yield, it is necessary to sow the best kind of seed for the land, and choose the fertilisers best suited. In Bohemia and Moravia the cultivation of barley has been so perfected that those varieties always, it is said, command the highest price, the fine qualities bringing from 10d. to 1s. 6d. a bushel more than the

inferior. The success of barley culture in France is stated to be assured more by the demands for export than for home consumption. The amount of beer at present consumed in France does not exceed 220,000,000 gallons, and the French breweries employ only about 5,000,000 hundredweights of barley a year. The foreign demand for barley in the surrounding countries will, says the United States' commercial agent, always furnish a good market, because England, whose annual production of beer is from 990,000,000 to 1,100,000,000 gallons, is dependent upon foreign supplies for about 14,000,000 hundredweights of barley. Germany imports annually 10,000,000 hundredweights; Belgium over 2,000,000, and Switzerland 400,000 hundredweights.

THE FORESTS OF ANNAM.

The forests of Annam have recently, says the French *Moniteur Officiel des Commerce*, been explored by one of the officials of the Forests Department, who was instructed by the French Government to examine and report upon them, particularly with reference to their extent, and the possibility of their practical utilisation. The first information obtained upon the subject relates to the forests of Nghê-An, in the province of Vinh. These forests are situated in the mountains, and at some considerable distance from the coast, covering almost the whole of the district watered by the Song-Ca river, commencing at Luong, and its principal tributary the Song-Cong. The lower vegetation covering the soil, and the almost impenetrable network of tropical climbers which reach up to the higher branches of the trees, render it extremely difficult to penetrate far into the heart of the forests. The woods met with in the forests of Nghê-An are very varied and numerous, but the most important, and those in which considerable trade is carried on, are the *go-liem*, or iron wood, and the *govan-tam*. The other descriptions of wood, although often more valuable, are much rarer, and therefore less frequently met with on the various markets. The *go-liem*, or iron wood, is hard but brittle, of a brownish-red colour, and would last a very long time were it not for the injuries inflicted upon it by white ants, which attack and speedily destroy it. In spite of this it is eagerly sought after and is of great utility, being employed in the construction of columns for pagodas, and houses, piles for bridges and platforms, furniture, coffins, junks, &c. Its weight is about 1,100 kilogrammes the cubic metre. It takes a good polish, and hardens in course of time. It is brought to market in logs of from five to eight metres in length, and sometimes, but less frequently, from ten to twelve metres in length. The *go-liem* is largely exported. The *govan-tam* is a yellowish white wood, with a very fine grain; it is easily worked, is very light, and polishes well. It is

used for the common kind of furniture, mouldings, boxes, and ordinary coffins, the hulls of junks and sampans, oars, &c. Its most frequent use is in shipbuilding. Beyond these two descriptions, which from a commercial point of view are the most important, there are a number of other woods little used by the Annamites, either on account of their scarcity, or because they are considered to be little capable of being worked up. They are, however, says M. Thomé, well deserving of some attention, by reason of the fact that Europeans might find a use for this excellent raw material which the Asiatic appear incapable of doing. The principal of these woods are the following. The *sanglé*, of a yellowish brown wood, which gets darker with time; it is a rare and very dear wood, not decaying under water, very heavy, and susceptible of a good polish. It is frequently employed in the construction of the better class of junks, and is sold in the markets in logs sawn through the middle; this is done because the purchaser paying a high price for this particular description of wood, insists upon seeing the condition of it throughout. This wood has no sap, and it frequently attains a height of 18 metres. The *yé* is a rose-coloured wood, scented and capable of a good polish; it is light, and is not attacked by ants. There are two varieties of this wood, the *yé-baï*, or white, and the *yé-van*, or yellow. The *ven* is a dark yellow wood, becoming brown with age; it is light, and is fit for ordinary carpenters' work. The *gavi* is a yellowish-white wood, heavy, and with long fibres. It is sold in planks from 12 to 15 metres long, and is used for framework and in the construction of junks. The *tio* is a red, hard, and heavy wood, with a coarse grain, and the *tine* is a purple-coloured wood, tender, and with very fine grain. The latter, says M. Thomé, might well be used for cabinet-making. The *goï* is a red-coloured wood, and the tree attains a height of from 10 to 13 metres; it is useful in carpenters' and cabinet-makers' work. The *bop* is a white wood, extremely light (very much resembling cork), polishes well, and would be useful to joiners. The *meucque* is a light, white wood, used for making *sabots* for the Annamites. The *goo* is a very fine, light, and well-veined wood, becoming black with age, scarce in Nghê An, but abundant in Ha-tinh; it is used for inlaying work. The oak, thus named because it resembles the European oak, is a heavy wood of mahogany colour, has a good polish, and is used in cabinet work. Among the other principal woods in which a considerable trade is carried on may be mentioned the bamboo, rattans, *cunao*, *wang sao* (a parasite plant used in Chinese medicine, and very expensive), and cinnamon. From the clearings to the banks of the river the logs and planks of wood are dragged by buffaloes, rafts are then formed, which descend the stream from Nghê-An and Ha-tinh in all seasons except when the waters are exceptionally swollen. During the dry season the streams have always a sufficient amount of water to

allow the rafts to go down to the sea. The province of Nghè is one of the richest in Annam from a forest point of view, and the Song-Ca and Song-Cong, streams which traverse the forest region, form excellent means of transport for articles so heavy and cumbersome as timber.

GEM MINING IN SIAM.

The region in which gems, including rubies and sapphires, have for the past ten years been found, lies situated on the western side of the Cambodian peninsula, about 240 miles south-east of Bangkok, and covers, approximately, an area of 100 square miles. The centre of that district is Chantabun, a seaport with a good harbour, connected with Bangkok by a line of three small steamers running at regular intervals. It is stated in a recent report to the Foreign-office, that within three hours walk from Bangkok, to the north-west, is Ban Kacha, where rubies of a very inferior kind are still sought after by the local inhabitants, both Siamese and Chinese. Tongsoos, or natives of Pegu, and Burmese do not work there. Again, twelve hours distant from Chantabun, are the mines of Müang Krung, with a mining population of about 100 in all, mostly Tongsoos, with a few native Siamese and Chinese. Two days journey from Chantabun, in a southerly direction, is the district of Krat, with mines from which rubies are extracted, and but few sapphires. The Tongsoo workers there number about 3,000. On the eastern side of the hill range, and three days journey due east from Chantabun, midway between that town and Battambang, are the Phailin mines, the most extensive and most frequented of all. Here there are between 4,000 and 5,000 gem seekers. Rubies and sapphires are both found, the latter being more abundant. The rubies at these diggings, although more rarely met with, are said to be of higher value than those discovered at other places in Siam. A stream which rises in the hill ranges, passes through the neighbourhood of the mines on its way to the Thale Sap and the Cambodia river. All three of these localities—Krung, Krat, and Phailin—have been, or shortly will be conceded on mining leases. The method of obtaining the precious stones is identical at all the diggings in the region of Bangkok and is as follows:—The intending digger, on entering the district, pays three ticals (5s. 3d.) to the headman, a Burmese British subject appointed by the British Legation, and responsible to the governors of Battambang and Chantabun, according as the fees received are derived from the Phailin or Krat mines. Beyond this tax there is no further fee exacted. The Siamese Government claim no right to pre-empt gems found, or to purchase at market value all stones above a certain carat weight, as was the case in Burmah. The Tongsoo digger's first object is to

discover a layer of soft, yellowish sand, in which both rubies and sapphires are deposited. This stratum lies at depths varying from a few inches to twenty feet on a bed of subsoil, on which no precious stones are found. A pit is dug until this corundum is exhausted, and the soil removed is then taken to a neighbouring canal or stream, one of which runs in the proximity of the mines, both at Phailin and Krat, where it is mixed with water, and passed through an ordinary hand-sieve. In his search for this peculiar alluvial deposit, which is generally free from any admixture of clayey earth, the digger has often to penetrate into the jungle that grows thickly around, and combining the work of clearing with the occupation of gem digging. The Tongsoos do not appear to form themselves into companies for mutual assistance or division of profits. They work principally in twos and threes, and if chance lead them to discover a gem of any value, they either undertake a sea voyage to Rangoon or Calcutta for the purpose of obtaining a good price for it themselves, with the dealers in precious stones at these places, or consign their acquisitions to an agent, while they themselves continue to search for more. A process of migration is continually going on amongst the Tongsoos of the different mines, the workers passing from one to the other, according to the reputation of a particular mine at certain periods. No artificial or mechanical processes for the washing of the soil have as yet been introduced, nor have gems been discovered in fissure veins of soft material embedded in crevices of hard rock, or in crystal form. Rubies and sapphires are found at all the diggings, often deposited side by side in the same layer or stratum of sand. The ruby of "pigeons' blood" colour is rarely, if ever, met with. The colour of the Siam ruby is usually light red of a dull hue. The sapphire is of a dark, dull blue, without any of the silken gloss which is the distinctive mark of the Burmah and Ceylon stone. Stones resembling garnets rather than rubies are found in the dried beds of watercourses at Raheng, two hundred miles north of Bangkok, and there is every reason to believe that rubies also equal, if not superior, to those discovered in the south-east, exist throughout the Raheng district. Those hitherto obtained are the result merely of surface scratchings by Tongsoo seekers.

AGRICULTURE AND LIVE STOCK IN THE ARGENTINE REPUBLIC.

M. Latzina, Director-General of the Statistical Bureau of the Argentine Republic, in the introduction to his lately published work on the condition of that country, says that of the 289,400,000 hectares (hectare = 2.47 acres) of land in the Republic, 2,360,000 were under cultivation in 1888. A third of this cultivated area, viz., 820 hectares, were under wheat; 832,000 hectares under maize; 380,000 under lucerne, 17,000 under flax; 36,000 under oats,

27,000 under vines, and 21,000 hectares under sugar-canes. In 1889 the area under wheat cultivation was further increased, 1,035,000 hectares being under this crop. Thirteen years ago, in 1875, it was estimated by the Inspector of Agriculture that the area under wheat did not amount to more than 100,000 hectares. As regards the live stock, the first attempt made to improve the breed of sheep was in 1826, when a hundred Spanish sheep were imported, and in 1830 a flock of English southdowns. In 1875, the number of horses, according to the official statistical returns, was 3,969,000, of oxen 13,493,000, and of sheep 27,546,000, and these numbers had risen respectively, in 1888, to 4,398,000, 22,869,000, and 70,453,000. The value of wool exported from the Argentine Republic in 1889 amounted to £11,200,000.

Obituary.

JAMES SHIRLEY HIBBERD.—Mr. Shirley Hibberd, the well-known horticulturist, died suddenly at his residence at Kew, on Sunday morning, 16th inst. He began life as a bookbinder, but soon abandoned that calling and applied himself to journalism. He was editor of the *Gardeners' Magazine* for many years, and published several works of value on horticulture. At the recent fruit show at the Guildhall Mr. Hibberd was one of the judges, and in recognition of his services on that occasion he was offered by the Fruiterers' Company the honorary freedom and livery of the guild, but he declined the honour on account of the pressure of his literary engagements. Mr. Hibberd was one of the founders of the several potato exhibitions that were some few years since commenced at the Crystal Palace, and only a few weeks ago he was called on by the Government to give them the benefit of his advice with reference to the potato disease in Ireland. He also took an active part in the recent discussion on the possibilities of fruit culture in England. Mr. Hibberd, who was in his sixty-sixth year, had been a member of the Society of Arts since 1876.

General Notes.

YORUBA TIMBER.—The Colonial authorities of Lagos are anxious to develop a trade in Yoruba timber. With this object, a circular has been issued in the colony, stating that the Government will readily receive specimen logs of native trees, and will send them to England to be reported on and valued by experts. It appears that throughout the colony there exist a large number and variety of timber trees, and that that part of West Africa (in

common with the Gambia and the Gold Coast) is rich in cabinet woods of good quality and appearance. The co-operation of all who are interested in the matter is invited. Communications on the subject should be addressed to the Colonial Secretary, Lagos.

MEETINGS FOR THE ENSUING WEEK.

- MONDAY, Nov. 24.** SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "Gaseous Illuminants." (Lecture I.)
 Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. T. A. Dickson, "The Labour Question as regards Agriculture,"
 Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. A. Maund "Matabele and Mashona Lands."
 Actuaries, Staple Inn Hall, Holborn, 7 p.m.
 Medical, 11, Chandos-street, W., 8½ p.m.
 London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. Pater, "Prosper Mérimée."
- TUESDAY, Nov. 25.** Society of Architects, St. James's-hall, Piccadilly, W., 7½ p.m.
 Sanitary Institute, 14 A, Margaret-street, W. 8 p.m. Mr. A. Wynter Blyth, "Sanitary Laws and Regulations Governing the Metropolis."
 Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.
 Civil Engineers, 25, Great George-street, S.W. 8 p.m. Professor John Milne and Mr. John McDonald, "The Vibratory Movements of Locomotives."
 Anthropological, 3, Hanover-square, W. 8½ p.m. 1. Mr. J. Theodore Bent, "The Yourouks of Asia Minor." 2. Mr. A. L. Lewis, "Stone Circles in Wiltshire."
- WEDNESDAY, Nov. 26.** SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Francis Galton, F.R.S., "Physical Tests in Competitive Examinations."
 Geological, Bunlington-house, 8 p.m.
 Royal Society of Literature, 20, Hanover-square, W., 8 p.m.
 Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Mr. G. G. M. Hardingham, "Working German Patents" 2. W. Lloyd Wise, President, "Specifications with especial reference to a recent judgment."
- THURSDAY, Nov. 27.** Royal, Burlington-house, W., 4½ p.m.
 Antiquaries, Burlington-house, W., 8½ p.m.
 London Institution, Finsbury-circus, E.C., 6 p.m. Mr. H. Blackburn, "Pictures of the Year."
 Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on papers by Prof. W. E. Ayrton and Mr. E. W. Smith, "The Efficiency of Secondary Cells," and "The Chemistry of Secondary Cells."
- FRIDAY, Nov. 28.** Clinical, 20, Hanover-square, W., 8½ p.m.
 Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Dr. Gladstone and Mr. W. Hibbert, "Notes on Secondary Batteries." 2. Prof. S. P. Thompson, "An Illustration of Prof. Ewing's Theory of Induced Magnetism."

CORRECTION.—In the announcement of Professor Vivian Lewes's Cantor lectures on "Gaseous Illuminants," in the last number of the *Journal*, the date of the first lecture was printed, by mistake, as November 25 instead of November 24.

Journal of the Society of Arts.

No. 1,984. VOL. XXXIX.

FRIDAY, NOVEMBER 28, 1890.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Professor VIVIAN B. LEWES delivered the first lecture of his course on "Gaseous Illuminants," on Monday evening, 24th inst.

The lectures will be printed in the *Journal* during the Christmas recess.

UNION OF INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Central Young Men's Christian Association, Exeter-hall, Strand, W.C.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 26, 1890; SIR WILLIAM S. SAVORY, Bart., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Birkbeck, Henry, 34, Southampton-buildings, Chancery-lane, W.C.

Bostock, George Henry, Hatfield, Yorkshire.

Doubleday, William Bennett, 123, Tulse-hill, S.W.

Ebb-Smith, Joseph, Worcester-house, Walbrook, E.C.

Few, William Resbury, Oaklands, Southfields, Wandsworth, S.W.

Levey, George Collins, C.M.G., National Liberal Club, S.W.

Lucas, Charles Phipps, The Elms, Mottingham, Eltham, Kent.

Pope, Henry R., 34, New Bridge-street, E.C.

Roberts-Austen, Prof. William Chandler, C.B., F.R.S., Royal Mint, E.

Ruffer, Marc Armand, M.A., M.D., B.Sc., 27, Torrington-square, W.C.

Woolcombe, Robert Lloyd, LL.D., 14, Waterlooc-road, Dublin.

The paper read was—

PHYSICAL TESTS IN COMPETITIVE EXAMINATIONS.

BY FRANCIS GALTON, F.R.S.

In the autumn of last year, I brought the subject of the present paper before the Anthropological Section of the British Association. My views and proposals were favourably received, and, in the end, the Council of the Association were instructed to consider them at leisure, and if approved, to submit them to the authorities of the Army, the Navy, and the Indian Civil Service, and to the Civil Service Commissioners. This was done, and the replies were communicated by the Council to the Association at their recent meeting at Leeds.

It appears, from these replies, that the Civil Service Commissioners, moved thereto by the India-office, are now engaged in considering the practicability of the proposals. In the meantime the public are imperfectly informed of a matter that ought to interest many homes, whence candidates will shortly proceed to compete for Government appointments; while a few notes of alarm have been sounded by prominent newspapers, chiefly, as it seems to me, through misconception. I am glad, therefore, of the opportunity of making a fresh statement, with the emendations that have occurred to me, or have been suggested to others. I hope it may disarm some objectors, and more especially that it may encourage constructive criticism, which would be timely and, I presume, not unacceptable to the authorities, whose decision is still in the balance.

General Statement.—I will begin with a platitude that is also a truism, namely, that in selecting candidates to fill posts for which physical efficiency is desirable, it is proper that physical qualifications should be taken into account, supposing always that the existing system of study is not affected by doing so.

High physical powers are advantageous in certain active professions, or at least in some

of their branches, and it is for these only that their recognition as subjects of examination is proposed. It is intended to be supplementary to the existing system and not to displace any portion of it. I neither praise nor dispraise that system, but leave it alone, including the medical pass examination, just as it is now, or as it may hereafter be modified; I am only concerned with faculties that are untouched by the present literary examinations, and which admit of being tested, as I shall show, without requiring special preparation on the part of the candidate that might distract his attention from his books or exhaust his energy and brain power.

Subject to these important reservations it is a mere truism to say that physical efficiency ought to be taken into account in selecting men to fill the particular posts above alluded to. My object to-night is to show that feasible and trustworthy tests exist, and to explain that if they be applied tentatively and on a small scale, with the avowed intention of reconsidering the whole matter after a few years experience, very considerable improvements of method are likely to follow.

Athletic Competition.—It will prevent one large class of objections from obtruding and distracting the attention if I first disclaim all intention of proposing athletic competition. A scheme in which that was proposed was brought forward in a report presented to the House of Lords on June 28, 1878, by a joint committee of the War-office and of the Civil Service Commissioners. It was discussed three times in the House, and objections were raised against it. It was said that the cost of preparation to the candidates would be considerable, and that the strain of athletic training would be more than the health of the already fully worked students could safely bear. So the recommendation of the committee was not adopted. The objections to athletic competitions appear to me both reasonable and forcible, and I have neither the wish nor the intention to advocate them. What is proposed is to test, not the most that a candidate could do after a severe course of training, but his natural capabilities.

Inspection.—The distinction I wish to draw is familiarly illustrated in the two methods of valuing horses. The athletic competition is that of the racecourse. The horses are trained for a long time at great cost till they reach the utmost efficiency that their natures permit, and then they are run against one another. The other method is in much more common

use, as in buying horses at marts. The animals are looked over in their stalls, they are led out into the yard and put through their paces, and they are shrewdly valued after brief inspection. If the horse is young or out of sorts allowance is, of course, made for these temporary drawbacks to efficiency. The scheme of examination that I propose is of this latter kind, supplemented by simple physical tests, which serve as a backbone to the otherwise unchecked judgment of the examiner.

One of the proposals is, that the medical man who conducts the pass examination should in addition to his present duties, assign marks to each candidate according to his opinion of the physical efficiency of the candidate, after examining him. The practice is common of inspecting the candidates for adventurous services before making a final selection. It is certainly sometimes, and I believe always followed, in picking out the best men for such special work as arctic and other exploration. Indeed, it would be preposterous to neglect so obvious a precaution against gross mistakes.

I have often heard, or read, though I cannot now give good references, that when the practice of selling or buying slaves was practised by men of our race, with few qualms of conscience, the slaves were priced after a minute inspection. An experience of my own, of some forty-five years ago, while travelling in the Soudan, is to the point. An Egyptian, who possessed little besides a sword, had attached himself to the caravan with which I was travelling. He was on his way to join a slave-raiding expedition on the borders of Abyssinia, and he had, I found out, considerable experience in slave markets. I asked him many questions, from time to time, about the valuing of slaves, and, at last, begged him, as a favour, to price myself, just as if I was a light-coloured African; for I was curious to know my worth as an animal. He took evident pains, and I think was fairly honest, though with a bias towards flattery. Having regard to the then high state of the market, he estimated my worth on the spot, at a number of piastres that was about equal to £20.

I had the opportunity, a few months since, of seeing a collection of private memoranda that had been made by a gentleman who had occasion, from time to time, to select candidates for an important service. For reasons which I can appreciate, he begged me to give no clue whatever either to himself,

to the nature of the service, not even as to nationality. I was amazed at the variety of his epithets (I will not say in what language), and at his skilful delineations of the characters of the candidates by a sentence or two, not drawn in coarse blacks and whites, but with delicate and humorous shade. I begged and prayed, in vain, to be allowed to take away with me a few anonymous extracts, and to publish them. If this could have been done, they might have given considerable impetus to the progress of the rare art of skilfully drawing characters. Here, then, I found a case in which selection was largely determined by inspection, not of physical qualities only, but of demeanour as well. Character, as a whole, does not concern us now, but a manly bearing and an air of general intelligence may do so to a certain degree, and these might well be taken into some account, as they are not touched by the literary examination.

Physical Tests.—I will next speak of the physical tests that are at present available, and afterwards of the way in which a system of marks may be founded upon them. So far as these particular tests are concerned, no latitude is left for uncertainty of judgment. They are definite measures made with standard instruments. The uncertainty is confined to the value of the deductions to be drawn from them. They are as follow:—

1. Stature.
2. A few other linear measures, sufficient to show whether the principal dimensions of the body are or are not well proportioned. These include the span of the arms, the height above the seat of the chair when sitting, and the length of neck.
3. Weight.
4. Strength of grasp.
5. Breathing capacity.
6. Quickness of response to a signal by sound.
7. Quickness of muscular action.
8. Simple tests of vision.
9. Ditto of hearing.

The length of time requisite to make a set of these measures is less than a quarter of an hour. I have caused many thousand sets to be taken that were more extensive than these, and which severally occupied little more than that time. Some were carried on at an anthropometric laboratory that I set up in the International Health Exhibition in 1884, and the rest at another that has been for two years in operation in the western galleries of the science collections at South Kensington. The work-

ing of the process is therefore thoroughly understood. So is its total cost, which including superintendence, registration, and bookwork, need not, under judicious management, exceed 6d. per head.

Instruments.—I exhibit a few of the instruments I am now using. They are mostly well known, but that for the measuring the quickness of response has been got into its present very convenient shape only about a year since,* and that for quickness of muscular action has been contrived still more lately.† It is almost needless to say that both of these qualities can be measured by more than one elaborate and troublesome method. For instance, by electrical action on a very light style, that lightly scratches the smoked surface of a revolving cylinder, whose rate of movement is recorded by another style attached to the end of a stiff spring, and which is maintained in vibration by an electrical impulse at the end of each excursion. This instrument is familiar to physiological students, and is most exact in its records; but it is far too troublesome for the purposes which we are now concerned. Hipp's chronograph is less troublesome, but it, too, is tedious. Something much readier to use and simpler to read off, is necessary if many persons are to be tested in rapid succession. The two instruments that I exhibit fulfil these requirements, and are at the same time more exact than is really needed.

The most difficult of the measures is that of the keenness of hearing. It is impossible, under the conditions of an examination, to obtain standard sounds, because the loudness of any note or noise is largely affected by the arrangements of the room in which the instrument may be set. The test to be employed must, I fear, be of a very ordinary kind, and of the same general character as the greatest distance at which a particular watch can be heard to tick, or a small electric bell to tingle.

I will not occupy time by explaining the process of performing the physical tests. They have been often described, and can be seen in operation at my laboratory by any one who chooses to go there, for it has hitherto been and still is freely open to the public. It is entered from the new Imperial Institute road, near to its end in Queen's Gate.

Marks.—The question is, what to do with

* For first account see "Journ. Anthropol. Inst.," xix. 1, p. 28; for a second account, "Report Brit. Assoc. for 1889," p. 784.

† "Journ. Anthropol. Inst.," xx. 2, p. 209

the measures after we have got them? How are they to be utilised as a basis for assigning a just allotment of marks? The real difficulty lies in these details, and not in accepting the general principle of the proposed examination. Later on I shall describe the safest guidance for drawing up a scheme of marks, but it is hardly available now. It would be attained after trying that tentative and provisional system which is asked for. There are three groups of faculties that must be dealt with differently.

First Group.—The more highly a man is gifted with the five following faculties, the better it would be for him in such posts as we are considering:—Absolute strength, quickness of response, swiftness of muscular action, keenness of vision, keenness of hearing. These faculties are also fairly independent of one another. It follows that we might with propriety mark the candidates according to their measured achievement. Again, it is a rough-and-ready practice to arbitrarily fix two limits in each case. Those who fall beneath the lowest limit are to obtain no marks at all. Those who exceed the highest are to obtain a certain maximum of them; for simplicity of illustration let us say ten. Then an achievement halfway between the limits counts as five, and others proportionately. This is by no means an ideally exact way, but it is good enough for our present purpose. In arbitrarily fixing the limits, we must be guided by some reasonable idea, and the one I should suggest is to take, either exactly or approximately, the lines that respectively cut off the lowest 5 per cent. and the highest 5 per cent. of men of the same age and social status as the candidates. I possess plenty of such statistical measures as these, which are very nearly, if not exactly, applicable to the candidates in view. It will be sufficient to give, merely as an example, a few figures from a table of values that I compiled from the measures taken at the International Health Exhibition of youths between the ages of 23 and 26. The upper and lower limits for strength of grasp are here 56 and 96 lbs. Five per cent. of the whole number stood below the first limit, and 5 per cent. above the second; but, according to the principal laid down, we arbitrarily refuse either to give negative marks for the very weak, or more than a certain maximum of marks to any man, however strong.

To reduce all this to as simple form as possible, let us suppose a maximum of ten

marks; then we might change the limits a little, for the sake of obtaining round numbers, and allot no mark for a strength under 55 lbs., and one mark for each additional 5 lbs. above that limit, up to 105 lbs., as a maximum. If the maximum marks were to be other than ten, the rule would be modified accordingly, but the general principle would be the same. There is no difficulty of importance in this method of devising a system of marks. Neither would there be any difficulty in its practical application. The marks might be engraved on the scales of the various instruments, together with the correction to be applied for age in the case of absolute strength and of swiftness.

The maximum number to be allotted to each of the five faculties* I have mentioned would have to be arbitrarily determined, according to some common sense view of the whole case.

Second Group.—A second class of qualities has to be estimated relatively to one of the others, not independently or separately, like those just discussed. At least three faculties fall within this group, namely, strength and swiftness, considered from a fresh point of view, and breathing capacity. Here the examiner would probably work with printed tables, in each of which the measures of one faculty would be arranged along the top at the heads of successive columns, and those of the related faculty down the side at the beginnings of successive lines. The marks and the age correction would be read off in the square where the appropriate column and line crossed each other.

In the sense in which strength is now to be considered, a racer is stronger than a cart-horse. Though he cannot perform the same amount of work measured in foot-pounds, he is able to transport himself, and move his limbs the more easily of the two. His strength, relatively to his weight, is greater than that of the cart-horse. It is easy to express the value of this fraction. Strength is supposed always to be measured in the same units: say, in the number of pounds weight that the grasp can resist. Weight is also supposed to be always measured in the same units: say, in pounds

* I may here mention that the literature connected with "Reaction Time" is voluminous. It has been much experimented on, because it affords a powerful aid to psychological research. A remarkably clear and able compendium of what has been achieved by its measurement has just been published in a little book by Professor Jastrow, called "Time Relations of Mental Phenomena." (Hodges: New York, 1890.) A very useful bibliography of works of reference is contained in it.

also. Then the fraction we want has the units of strength for the numerator, and units of weight for the denominator, which is easily turned into an ordinary decimal. Then, just as in the first method, we find two limits of value. Those whose record falls beneath the lower limit receive no marks at all; those who rise above the upper, receive the maximum.

Swiftness should also be treated relatively to weight, though not as a fraction but as a product. The units of swiftness have to be multiplied into the units of strength, to measure the momentum of a blow or of a rush.

Lung capacity has to be treated on parallel lines to strength. The human body is a locomotive worked by a chemical engine. It is stoked with food, and pumps in air to burn waste products; then it pumps out the air after it has been vitiated by the burnt products, doing this in alternate rhythm. A respiratory apparatus, that is amply large enough for a small human body, may be altogether inadequate for a larger one. Therefore it is the lung capacity relatively to the size of the body that concerns us, and not the lung capacity in an absolute sense. We have to regard the fraction in which the numerator is the number, say, of cubic inches of lung capacity, and the denominator is the number, say, of pounds in the weight, or else some function of the number of inches in the stature. The marks can then be assigned as before.

Third Group.—As regards symmetry, I have little of my own to say that is worth saying. The normal proportions of the body are pretty well known in the different races, and it is presumable that a wide departure from them in any direction is prejudicial. We have here an instance of a third class of qualities, where the broad belt of average values would receive full marks, and deviations outside of it on either hand, would receive fewer, until at the limits roughly determined as before on the 5 per cent. principle, they became *nil*. There is at least one simple method of rapidly finding out the marks to be assigned in the cases that fall within this group, but I will not stop to describe it, as I cannot do so very briefly.

Stature is another instance of the same sort. It is largely dependent on race, but in each race there is a normal value. Moderate departures from the normal are not important, but wide ones are, whether in excess or deficiency. Some information about this is to be found in Gould's "Statistics of the American

War," published by the Medical Department of the United States.

It will now, I hope, be understood that there is no important difficulty of principle in assigning fair marks to the results of physical tests, and that if the principle is agreed upon in the sense just explained, its practical application is simple.

These physical tests would afford guidance to the examiner in assigning the marks he has to give according to the result of his inspection. If his judgment appears to be contradicted by the tests, he would reconsider it; if corroborated by them, he would feel the more assurance in his view. The tests would afford a valuable safeguard to the correctness of the final opinion of the examiner.

All that have thus far been proposed could be carried into effect at once. I shall afterwards discuss the directions in which the experience of a few years might be expected to suggest improvements. In the meantime it will be well to answer objections that have been brought against the proposal generally.

First Objection.—The two objections that have been most frequently urged are merely blows in the air, struck wide of the scheme, as it will be easy to show. The first is that certain great commanders and strategists had a poor physique, and would have been excluded by the proposed tests from the profession in which they afterwards distinguished themselves; that Nelson, for example, would have been excluded. The reply is that the proposed plan does not peremptorily exclude anybody on the ground of poor physique. There exists already a very salutary medical pass examination that excludes youths who appear to be distinctly unfitted for active service; but the new and additional proposal merely asks that a candidate who is below par in bodily powers should be above par in mental powers as a counterpoise. There is a rather broad belt of barely distinguishable degrees of mediocrity of mind, through or near to which the line runs that divides success from failure in the ordinary competitive examinations. But among the candidates who fall within this belt we may expect to find just as great a variety of bodily powers as among any other group of candidates. It is upon these only that the proposal to give moderate marks for physical efficiency would have any effect of importance. It would raise some men of mediocre intellect, but of powerful frames, into the pleasant table-land of success, and it would

depress an equal number of men of almost equal mediocrity of intellect but with puny bodies as well, into the gulf of failure. The State would gain by the exchange. As for the candidates who had a fair place in the literary class list, the total want of extra marks for bodily efficiency would be insufficient to exclude them. It would only make them lose a few places.

The discovery of Dr. Venn* is most important to us here. He found that the three classes of high honour men, poll men, and of those who were intermediate between the two, have on the whole almost exactly the same average physical faculties, and that the degree of individual variation amongst them is the same in both classes. He discussed with thoroughness and ingenuity two considerable batches of measurements that were made at Cambridge with some instruments I had set up there, both of which told the same tale independently. That men who are mediocre in intellect are not also mediocre in physique, but are just as variable as any others, has therefore been shown to be a trustworthy fact, and the absurdity of taking no account of their variability becomes conspicuous.

Second Objection.—The second objection is that these tests take no account at all of the important quality of energy, which includes pluck, strong will, and endurance. I fully grant it, but half a loaf is better than no bread. The proposed tests tell us something useful that was disregarded before. They do not profess to cover all the *lacunæ* left by a literary examination. There remain an abundance of important points of character, moral and other, that are wholly undealt with. We must be content with what we can get. It is not impossible that practicable tests of energy in some of its forms may yet be discovered. It must be associated with physiological signs that we have not yet had the wit to discover. The power of enduring fatigue evades measurement, owing to its being largely affected by practice and athletic training; and there occurs, as yet, no way of estimating these disturbing causes. Put one of two similar youths into high training, and he will climb mountains, run races, and so forth, without any disturbance to his health, which the other could not attempt without serious risk. It is greatly to be regretted that we can devise no test for natural energy. It is a characteristic of great men to have an

unusually large share of it. Sometimes it shows itself in mental work, sometimes in bodily work; often in both combined. The work got through by great commanders, without injuring their health, is enormous. Brief hours of sleep, harrassing anxieties, multifarious objects of attention, climatic changes, are borne for months. Now and then occur the arduous preparations for a great battle, the fighting it, and afterwards a minute and lucid despatch has been written, perhaps in the late evening of the same day.

Third Objection.—Another objection concerns the untrustworthiness of the results of examination. There is no reason to suppose that physical tests would be more untrustworthy than literary ones; indeed, such experiments as have been made point the other way. I do not champion the system of examination, but as we have it, and as no one can devise a better way of selecting candidates, we ought to increase its value by making it less one-sided. Those who desire to have a definite notion of the variability of judgment in literary matters among examiners, should study the careful and ingenious memoir by Prof. F. Y. Edgeworth in the current number of the *Statistical Journal*.

Need of further data.—Before it is possible to devise as good a system of physical tests as we may reasonably hope at some time to obtain, we require observations in sufficient number and in a sufficiently exact form.

Worth of Physical Tests.—We have, for example, to compare the rank in physical efficiency that is assigned to youths by tests and inspection with the rank that they hold according to the consensus of their fellows and competitors in athletic sports. We should thereby ascertain more exactly than we can do now the relative importance that ought to be assigned to the various tests.

Promise in Youth.—Again, we have to compare the physique and promises of youth with their achievements in after-life. Now, we obviously cannot examine into this relation unless records are preserved and are easily accessible of the physical powers of youths. We require statistical data on a large scale before it is possible to deduce trustworthy conclusions; and it seems impossible to establish the needed system of records, except under the stimulus of such examinations as I have in view. If the present conditions continue unchanged, inquiries into the important question I have

* See *Nature*, 1833-90.

indicated will linger on indefinitely. It will remain in the hands of a few amateurs, whose energies are largely absorbed by the almost hopeless task of searching for materials. Apply the stimulus of examination, and not only will the required data begin to accumulate, but many intelligent schoolmasters and others will feel it a matter of business to discuss them. There ought to be no difficulty in finding out the physical antecedents of every man when he was a youth. It is easily to be done in respect to his class place in literary examinations, and the value of these in forecasting his future can be discussed; but there are absolutely no records worthy of trust, on a sufficient scale, in respect to his physical powers.

Vigour of Eminent Anglo-Indians.—I may here mention an observation that impressed me a good deal at the time. On the eve of the departure of the late Sir Bartle Frere on a high political mission to Africa, his numerous friends entertained him at a farewell banquet. I was present, and seized the opportunity of estimating, as dispassionately and as carefully as I could, the average physical appearance of the eminent Anglo-Indians, who were the preponderating element in the party. I was the more moved to do so because the first feeling was one of surprise at the difference between what they were and what I had expected. I was prepared to see a collection of bilious and worn-out men. Not a bit of it; they were remarkably hale and vigorous. They were above the average stature and breadth—there was an air of force and power about them. They were as fine a collection of human animals as I have ever seen. I am sure that such examiners as those I have in view, would have given high marks to most of them for physical efficiency.

Tolerance of Tropical Climates.—Our ignorance is crass in respect of not a few elementary questions of national importance, which cannot be answered until the habit of preserving physical records of youths shall have become more common than it is. One of these regards the indications that a youth will or will not be able to keep his health in a hot and feverish climate. No inquiry has ever been made into these with the thoroughness and precision that the question obviously deserves. There is great variability among men and animals of the same race in their power of enduring malaria and changes of climate. It has happened that I have been more than a

third of a century closely associated with the doings of the Royal Geographical Society, and during that time I have often had occasion to remark the ease with which the constitutions of successful explorers have thrown off the effects of fever. They may have been attacked frequently and severely but the malady rarely takes so strong a hold, as to leave them permanent invalids. Still less does it kill them, as it speedily kills many others who were, to all appearances, equally vigorous and energetic. A careful investigation of numerous cases would probably show that physiological signs might be discerned during youth, either of a natural immunity from malarious fever, or of a disposition towards it. It is cruel and costly to tempt youths to the tropics who are less constitutionally capable than others of thriving there. If we could distinguish those who are fittest for life in hot countries, we should select them even though in other respects they may be somewhat wanting. The tropical possessions of England are become so large that it is a matter of national importance to investigate this question thoroughly. It may yet be possible to find varieties of our race who are capable of permanently establishing their families in those climates.

It would be easy to enlarge on the topic of our astounding and contented ignorance of very elementary questions in respect to the choice of the men who are most likely to succeed in special services, but enough has been said to show the need of stimulating a demand for the collection of trustworthy records. No stimulus would approach in efficiency to that of establishing physical tests in connection with certain of the competitive examinations. If this were done provisionally, as proposed, and on a small scale, many persons who are connected with education, or with the public services, would interest themselves warmly in the subject. It would become a matter of present importance to themselves, and what is now only an academic question would be raised to the rank of a practical one.

I trust now that the two points have been established that it has been the object of these remarks to prove. First, that it is possible at once to devise a system of physical tests and inspection that shall be of real utility. Secondly, that in addition to its present value it would afford a necessary first step towards a more satisfactory scheme.

DISCUSSION.

The CHAIRMAN said that this paper would afford ample scope for discussion, as the subject was one on which wide difference of opinion might exist, not, indeed, on the principle itself, which was now conceded, for in many examinations physical tests were to a certain extent already used. The more difficult question to answer was the relative value to be attached to these tests, not only in comparison with literary work, but the relative value of the different tests themselves. To express it broadly, some might attach more importance to tests for mere strength, and some to those for physical health. He noticed that the author did not give so much prominence to personal and family history as some might be disposed to do. He took it Mr. Galton's motto would be *mens sana in corpore sano*, but there was a very broad and deep distinction between health and strength.

Admiral COLOMB said the subject of physical tests in competitive examinations was familiar now to every one in the army and navy, because it had been so much talked about, but until to-night he had only heard of it in connection with athletic competitions, which Mr. Galton proposed to discard altogether. So far as he understood the proposal, it would bring forward some useful men whose mental capacity was possibly a little below par, but who made up for the deficiency by their physical qualifications. Whether the Government would ever tentatively adopt such a system was a question, but one point struck him which might have some weight. In the old days a large number of officers were entered for both the army and the navy, and were then left to sink or swim as they could, and there was a sort of natural selection out of an immense body, the best men being retained for the services, and the others disappearing. That system had been abandoned, and by means of artificial tests the field from which officers were drawn was very much reduced. It therefore seemed desirable to make the examinations as complete as the knowledge of the time allowed, and he certainly thought that the tests described would help in selecting the best men and rejecting the worst. He should have thought a test of energy and possible capacity might be obtained from the pulse, the rapidity of the breathing and the effect of starts, and especially from the condition of the digestion. It was an old saying that a man "had no stomach for a fight," and he thought there was more in that than a mere trope. A man's want of courage might come from not having a good digestion. In the excessive fear experienced in dreams, the sensation felt on waking was always about the diaphragm, and when startled by a sudden apparition he had felt the same sensation himself in that part; so that probably digestion had a good deal to do with what was called courage and energy. One physical test not referred to was the cause of

more rejection in the navy than almost any other, and that was the teeth. Men whose teeth decayed when young were almost always rejected for the navy, because it was said to show a bad constitution and to prevent good digestion.

Dr. DELEPINE said he had been obliged for some time to study this question, for the purpose of providing information in certain quarters, and he had become acquainted, probably, with all the statistics and methods proposed for testing the physical powers; but the result was that very few data existed which could be applied to candidates of the age of those who came up for examination, and those which did exist were often not sufficiently accurate to allow of any system being based upon them. The only data at present were those collected by Dr. Roberts some few years ago, in which the questions of age, occupation, and the correlation of measurements had been compared; and even in those tables a great many things were wanting, which Mr. Galton had either provided, or, he hoped, would provide before long. The great difficulty seemed to him to be the correlation of the measurements of height, weight, muscular power, and respiratory capacity. If they were paired two by two, as Mr. Galton suggested, certain important connections were apt to be overlooked; for instance, if a man of a certain height weighed a little more than he should—if his muscular power and breathing capacity were not taken at the same time, the excess of weight would be deemed rather a deficiency, but if it were found that he had unusual muscular power, it was evident that the excess of weight might be due to a larger amount of muscle than the normal, and therefore the excess of weight would be a good feature. In the same way a man who measured more round the chest than he should, might be either too stout or more muscular than usual, or he might have a larger development of the lungs than normal. By taking all these four factors together all the required data were obtained. It would be impossible to obtain a satisfactory system of marking unless four or five measures were taken at the same time, and due correlation of the results must always have a chief place. There were other points which were not correlated, and which could be estimated on their own account; a man with good sight was certainly better than one with bad sight, and the same might be said of bad hearing. In awarding the marks also it should be remembered that the mean men of their race were generally found more serviceable than either very tall or very short men. The mean man, therefore, should have the maximum marks. It should also be remembered that there were two means, and sometimes more than two, in many races, which might be influenced by the occupation of the person himself or his ancestors.

Dr. BLACK (late Surgeon-Major) said he had had

considerable experience in examining recruits, both officers and privates, and he thoroughly appreciated the great and growing importance of this subject. The acquisition of this knowledge would eventually be of great service to the public, and would enable parents and tutors to judge of the character of the candidates they produced either for the public or private service. Mr. Galton disclaimed any kind of athletic exercises in examination, and reduced his observations to the powers of the candidates—mental, muscular, and nervous. Observations as to some physical features, stature, &c., had been made for years and years, and there were piles of books at the Admiralty and War-office containing the records of centuries; but new branches of inquiry were now opened up which were still capable of much greater development. The power of will, for instance, could be exemplified by the stroke or blow of the fist, if the instrument were properly adjusted. Another point was the power of the voice, which was of great importance both to the private seaman as well as the officer. The captain or the colonel had to make his voice heard on parade, and the boatswain also had often to produce his voice in the most decisive and peremptory manner. Mr. Galton had an instrument for testing the strength of the arm, but it was equally important to test the strength of the leg. Nothing could be of greater importance to a commanding officer than to know the power of his regiment to march; but that had not hitherto been at all investigated by any instrumental method; it was judged of simply by the eye and other means; but it could scarcely be judged of by the appearance of the men. It was well known that the British private was not good at marching, though he might have a good physical appearance and be a good boxer; the Frenchman would beat him in marching, and the reason of that should be ascertained, for it had not yet been investigated by physical observation. Again, the power of balancing was a good test of the perfection of the whole system. Recruits were tested by standing on one leg; that power of balancing showed the perfection of the nervous system, both in the spinal cord and in the brain. It was also important to ascertain whether a man were left-handed or not; both feet and both hands should be of equal power, and both legs also. In fact the suggestions which might be made were almost innumerable, and he only threw these out as perhaps worth consideration.

Sir DOUGLAS GALTON, K.C.B., F.R.S., thought one of the great advantages which would result from adopting this system of examination would be that it would direct public attention more to the necessity for combining some system of physical training with education. At present, in the elementary schools, we were only developing one half of the children; and it was most essential, if we were to produce a race which should at all compare with the pictures on the walls—the Greeks, who were the most highly civilised

race the world had ever seen—that the physical, as well as the mental qualities of the children should be developed; and their mental powers could not be developed unless their physical powers were developed also. On this account, it was of the highest importance that the Government should recognise the great labours of Mr. Francis Galton; and he trusted that before long some practical measures would be taken to adopt this system of marks in public examinations.

Mr. ROGERS pointed out that a great many civilians were now sent out to India of very different races, and that Bengalees, Parsees, and people from the upper provinces competed with Englishmen, Irishmen, and Scotchmen, and therefore he thought that the idea of putting them through a competitive examination in athletics might be relegated to the future. But after they had been through a literary course no one should be allowed to go to India unless he was able to ride on horseback, and showed a certain amount of physical energy.

Mr. GALTON, in reply, said one point made by the Chairman was that he had not said anything about heredity. He could only say that it was with great difficulty he refrained, but he thought it better not to encumber his paper with that important subject. He had been struck with the suggestion for testing the voice, and thought it would be very easy to devise an instrument for the purpose. The teeth would fall rather under the medical examination.

The CHAIRMAN, in proposing a vote of thanks to Mr. Galton, said there could be no nobler or more useful subject for consideration than the relation of the mental, moral, and physical qualities of man, and their influence on each other.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

SILK CULTURE IN NINGPO.

There are three kinds of silkworms in the district of Ningpo—the common, the horned, and the striped—all living on mulberry leaves. Consul Fowler states that there is also a worm which lives exclusively on the leaves of the oak. This comes from New Chwang. This worm is much larger and apparently harder to rear than the ordinary one. It is quite green in colour. The moth of this worm is of a deep yellow, and measures four inches across when the wings are spread out. On each wing are two or three transparent spots called eyes. The natural life of an ordinary silkworm, that is to say, from the time it is hatched to the death of the moth, is said to be from forty-five to fifty days, about five of which

are spent in spinning, ten in a chrysalis state inside the cocoon, and the rest of the time in a caterpillar state. When first hatched the worm is black and just visible, and when it is ready to spin it becomes about two inches long. While in a caterpillar state it has, what are called in Ningpo, four sleeps, about five days apart and twenty-four to thirty hours duration each. During each of these sleeps the worm moults. The silkworm spins on a whisk of straw from eighteen to twenty-four inches high. The whisk is made by taking a handful of straw and tying it a little above the middle and spreading the two ends until it is able to stand upright. The worm is put on this, and it crawls about until it finds a convenient place, when it begins spinning by hanging silk to the straw and then winding itself round, and in a very short time the worm is hidden from sight. In about four days the cocoon is completed. After this the reeling takes place; that is, it must be done within a week after the cocoons are completed, otherwise the chrysalis, becoming the moth, will eat its way through the cocoon, after which it is useless for reeling. The process of reeling appears to be a very simple one. All utensils used consist of an earthen furnace, over which is put an iron pan and a bamboo wheel three feet in diameter, worked with a crank. This wheel has no felly, and the exterior ends of the spokes are connected with thread or cotton twine. The spokes are set in twos into the nave or hub of the wheels in such a way as to form the letter V, and therefore instead of the felly, the cord connection passes from spoke to spoke, forming a regular zigzag. The cocoons are placed in the pan of water, under which a slow fire is kept; a stick is then used to stir the cocoons until the desired number of fibres (or ends of the silk) have adhered to it, then these are removed, and passed through the hole of a cast attached to the furnace, and then fixed on to the wheel. The wheel is now set in motion, and the reeling actually begins. It is said that an expert can reel off about a pound and a half of silk in a day.

THE FOREIGN TRADE OF BULGARIA.

The *Journal de la Chambre de Commerce de Constantinople* says that the returns of the Bulgarian foreign trade are showing a decided increase. Cereals, chiefly corn and barley, form the largest part of the exports of the country. A portion of these cereals is absorbed by other parts of Turkey, by Roumania, and Austria-Hungary, which apply them either to the requirements of local consumption or for their export trade. England, however, is the principal market for Bulgarian cereals. For the export of its products Bulgaria employs several routes. By the Danube route the trade with Austria-Hungary and Roumania is carried on; the trade with over-sea countries is carried on *via* Varna and Black Sea; hitherto the Principality of

Bulgaria has been obliged to use the port of Dedeahatch, on the Ægean Sea; for the future it will be independent of this by the construction of the Yamboli-Bourgas Railway, terminating on the Black Sea. Apart from the extensive plains of Sophia and Philippopolis, but situated to the south of the Balkan chain, there are the large plateaux situated to the north of these mountains, between them and the Danube, which are the granaries of Bulgaria. After cereals, the exports of Bulgaria almost entirely consist of articles of general consumption—cheese, butter, eggs, and cattle, which are sold to the neighbouring people. There are, however, some articles of which it makes, if not a monopoly, at least a special feature, these are raw skins, carpets, and essence of roses. Bulgaria exports annually about 80,000 goat skins, 15,000 kid skins, and 180,000 lamb skins. The carpets of Berkovitz, woven by the Bulgarians with woolspun and dyed by themselves, enjoy in the East a considerable and well-deserved reputation. Very much appreciated in Austria and Servia, they are not yet, it is said, sufficiently sought after abroad, as they are not yet thoroughly known. The industry of making essence of roses belongs exclusively to the districts situated to the South of Bulgaria. The production of wine in Bulgaria but little exceeds, on an average, a value of £96,000, which gives a value of about 7d. a gallon. Notwithstanding the low price, it has hitherto supplied nothing, or next to nothing to the export trade. Among the imports into Bulgaria, cottons supplied almost exclusively by England take the first place. Then come metals in bars, and manufactured in the form of machinery and other articles. Almost all these articles come from England; Belgium supplying also a small quantity. Austria sends to Bulgaria almost all the ready-made clothing, *articles de luxe*, and furniture which are sold there. Sugar also comes, for the greater part, from Austria. Petroleum is supplied by Roumania, Russia, and the United States. Germany sends different articles in ordinary use, principally cotton tissues and hardware. The importance of the Bulgarian foreign trade is far from attaining all the development of which it is capable, says the *Journal de la Chambre de Commerce de Constantinople*, but there is progress year by year, and the recent opening of the Yamboli-Bourgas railway, which secures to the country a new direct output in the Black Sea, will certainly result in still further accentuating this progress.

Notes on Books.

THE THRESHOLD OF SCIENCE. By C. R. Alder Wright, D.S., F.R.S. London: Charles Griffin & Co., 1890.

This work is founded on the late James Wyld's "Magic of Science," published thirty years ago, and

is briefly described on the title page as "a variety of simple and amusing experiments illustrating some of the chief physical and chemical properties of surrounding objects, and the effects upon them of light and heat." The advance in the popularity of science during the past thirty years is even greater than the progress of science itself; and it will, therefore, readily be perceived that there is not much room for the contents of this original work. Practically, indeed, this book may be considered as a new one, though here and there—as, for instance, in the chapter on photography—a somewhat undue amount of the old material has been suffered to remain. The experiments relate, for the most part, to chemistry or to light and heat. Some of them are of course familiar, but many are novel; and all are described in such a way as to be intelligible and interesting to the young student. The book should serve a useful purpose—by attracting young readers to the study of science, and inducing them to pursue it seriously. At the same time, it may serve to encourage those who have already commenced such serious study, by showing them the amusing and interesting side of their work.

TO SOUTH AFRICA AND BACK. By John Finch. London: Ward, Lock & Co.

The author, in a five months' journey to South Africa, visited Cape Colony, Natal, the Orange Free State, and the Transvaal, and in the narrative of his journey he gives special attention to the diamond and gold fields, relating anecdotes of the illicit diamond buyers and their tricks.

PUBLIC LIBRARIES: A History of the Movement and a Manual for the Organization and Management of Rate-supported Libraries. By Thomas Greenwood. Third edition, entirely re-written. London: Simpkin, Marshall, Hamilton, Kent & Co.

The first edition of this book was published in 1886, and was noticed in the *Journal* in that year. Since then much has been done in respect to the increase in the number of free libraries and in the production of labour-saving apparatus for their successful management. The author has brought the information up to date, and much enlarged his book.

DIE DECORATIVE KUNST-STICKEREI. I. Ausnäh Arbeit. Von Frieda Lipperheide. Berlin: 1890. 4to and folio.

This is a very elaborate work on art needlework, consisting of letterpress and illustrative plates. The various materials and instruments used in the practice of embroidery are described and illustrated; further on the different stitches are explained and specimens given. The atlas contains coloured lithographs of Spanish appliqué work of the 17th century, one exhibiting an escutcheon of arms. Italian appliqué of the 17th and 18th centuries and

French appliqué of the 18th century, also Spanish appliqué on a netted ground of the 17th and 18th centuries.

MUSTERBLATTER FÜR KUNSTLERISCHE HANDARBEITEN. Herausgegeben von Frieda Lipperheide. II. Sammlung (13-24 Blatt). Berlin: 1890.

This work, on a similar subject to the above, and by the same author, contains coloured plates of Oriental, Servian, Bulgarian, and Spanish patterns.

General Notes.

KEW REPORTS.—An index has now been issued to the Kew Reports from 1862 to 1882, the object of the index being to render the information contained in the Reports respecting economic and other plants more easy of reference. More detailed notes than those contained in the annual reports are now given in the Kew Bulletin, of which three volumes are already published, and the fourth is in course of publication.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

DECEMBER 3.—JAMES DREDGE, "The Chicago Exhibition, 1893." The ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

DECEMBER 10.—F. BAILEY, "Electric Lighting Progress in London." SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

DECEMBER 17.—GEORGE DAVISON, "Impressionism in Photography."

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at Half-past Four o'clock:—

January 20; February 17; March 17; April 21; May 5, 26.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday afternoons, at Half-past Four o'clock:—

January 22; February 26; March 12; April 9, 30; May 28.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 27; February 10; March 10, 24; April 14; May 12.

CANTOR LECTURES.

The following Courses of Cantor Lectures will be delivered on Monday evenings at Eight o'clock:—

Prof. VIVIAN B. LEWES, "Gaseous Illuminants." Five lectures.

LECTURE II.—DECEMBER 1.—The composition of coal gas—Analysis of gas—The illuminants present in coal gas—Effect of class of coal, methods of manufacture, and diluents present, on the illuminating power of coal gas—The methods employed to enrich coal gas.

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

January 26; February 2, 9.

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

February 16, 23; March 2.

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

March 9, 16, 23.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

JUVENILE LECTURES.

Two Lectures, suitable for a juvenile audience, will be delivered by E. B. POULTON, M.A., on "Mimicry in Animals," on Wednesday evenings, December 31, 1890, and January 7, 1891, at Seven o'clock.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 1. SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "Gaseous Illuminants." (Lecture II.)

Royal Institution, Albemarle-street, W. 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. J. J. F. Andrews, "Ship Caissons for Dock Basins and Dry Docks."

Microscopical, 20, Hanover-square, W., 8 p.m. Conversazione.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. W. Webster, "The Electrical Treatment of Sewage."

Royal, Burlington-house, W., 8 p.m. Anniversary. British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. Phené Spiers, "Sassanian Architecture."

Medical, 11, Chandos-street, W., 8½ p.m. Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Prof. Hull, "Geological History of Egypt."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. W. H. Corfield, "The Houses we live in."

TUESDAY, DEC. 2. Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Richard Crawshaw, "The Antelopes of Nyassa Land." 2. Prof. G. B. Howes (i.), "The Suspension of the Viscera in the Batoid *Hypnos subnigrum*;" (ii.) "Notes on the Pectoral Fin-skeleton of the Batoidea and of the Extinct Genus *Chlamydoselache*." 3. Mr. G. A. Boulenger, "The presence of Pterygoid Teeth in a Tailless Batrachian (*Pelobates cultripes*), with remarks on the localisation of Teeth on the Palate in Batrachians and Reptiles."

WEDNESDAY, DEC. 3. SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. James Dredge, "The Chicago Exhibition, 1893."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. George T. Baker, "Notes on the Lepidoptera collected in Madeira by the late T. Vernon Wollaston." 2. Mr. Frederic Merrifield, "The conspicuous changes in the markings and colouring of Lepidoptera, caused by subjecting the pupæ to different temperature conditions." 3. Mr. Hamilton H. Druce, "A Monograph of the Lycenoid genus *Hypochrysois*, with descriptions of new Species."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, DEC. 4. Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. N. Ridley, "The Genus of Orchid *Brownheadia*." 2. Mr. J. H. Lace, "The Botany of Kandahar." 3, 4. Mr. Thos. Kirk, "Botanical Visit to Auckland Isles."

Chemical, Burlington-house, 8 p.m. Dr. Branner, "The Volumetric Estimation of Tellurium."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Armbruster, "Hector Berlioz" (illustrated). Camera Club, Bedford-street, Strand, W.C., 8½ p.m. Mr. H. Sturmer, "Rollable Transparent Films."

Archæological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

FRIDAY, DEC. 5. National Association for the Promotion of Technical and Secondary Education (at the HOUSE OF THE SOCIETY OF ARTS), 5 p.m.

Teachers' Training and Registration Society (at the HOUSE OF THE SOCIETY OF ARTS) 8 p.m. Annual General Meeting.

Geologist's Association, University College, W.C., 8 p.m. 1. Messrs. C. Davies Sherborn and H. W. Burrows, "Report on the Microscopical Examination of some Samples of London Clay from the excavations for the widening of Cannon-street Railway Bridge, 1857." 2. Mr. Edwin Litchfield, "A short visit to Ingleton and to Filey Brigg (showing how a dangerous reef was converted into a perfect breakwater by an ancient race.)"

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, DEC. 6. Foremen Engineers and Draughtsmen, Cannon-street Hotel, E.C., 7½ p.m. Paper by Mr. W. Powrie.

Journal of the Society of Arts.

No. 1,985. VOL. XXXIX.

FRIDAY, DECEMBER 5, 1890.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the Course on "Gaseous Illuminants" was delivered by Professor VIVIAN B. LEWES on Monday evening, 1st inst.

The lectures will be printed in the *Journal* during the Christmas recess.

INDIAN SECTION.

A meeting of the Committee of the Section was held on Thursday, 27th ult., at 4 p.m. Present:—Sir GEORGE BIRDWOOD, M.D., K.C.I.E., C.S.I., in the chair; Hyde Clarke, Sir Theodore C. Hope, K.C.S.I., C.I.E., Major-General J. Michael, C.S.I., Thomas H. Thornton, C.S.I., D.C.L., Sir Charles A. Turner, K.C.I.E., and W. Martin Wood, with Sir Henry Trueman Wood, Secretary of the Society, and Mr. S. Digby, Secretary of the Section.

The programme of papers to be read during the present Session was discussed.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, December 3rd, 1890; the ATTORNEY-GENERAL, M.P., Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Blundell, Harold, 2, Croftdown-road, Highgate-road, N.W.

Brennan, Saint John, Savage Club, Adelphi-terrace, W.C.

Brocklehurst, Henry, Horneseston, Sefton-park, Liverpool.

Cox, H. Bertram, 15, Barton-street, Westminster, S.W.

Dunn, Archibald Joseph, 23, Applegarth-road, West Kensington, W.

Elms, Charles, 36, Mount Stuart square, Bute Docks, Cardiff.

Glegg, Patrick Adam, 5, Moorgate-street, E.C.

Lyall, George, 48, Winchester-street, South Shields.

McClure, William Lees, J.P., The Lathams, Prescott.

Mendelssohn, Hayman Seleg, 10, Pembridge-crescent, Notting-hill-gate, W.

Murray, James Charles, Holmsted, Bushey-heath, Herts.

Thorne, William, Burntwood-lodge, Wandsworth-common, S.W.

Verdin, William Henry, J.P., Darnhall-hall, Winsford, Cheshire.

Wiseman, E., Cheapside, Luton.

The following candidates were balloted for, and duly elected Members of the Society:—

Angell, Col. John Charles, 12, Bolton-gardens West, S.W.

Asch, William, Albert-mansions, 118, Victoria-street, S.W.

Aukland, Thomas Frederick, Loxley-house, 85, Cazenove-road, Stamford-hill, N.

Barrow, John, Beechfield, Folly-lane, Swinton, near Manchester.

Benest, Henry, 15, Campbell-road, Bow, E.

Binnie, Alexander R., 14, Campden-hill-gardens, W. Blackwell, Samuel J., Brookshill, Harrow Weald, Stanmore.

Briggs, William, Burlington-house, Cambridge.

Cameron, H. H. Hay, 70, Mortimer-street, W.

Carew-Smyth, Ponsonby M., 30, Moor-park-road, Walham-green, S.W.

Carr, Herbert Wildon, 34, Craven-street, Strand, W.C.

Carson, James Hamilton, 26, Old Broad-street, E.C.

Cheek, Philip, Baltic-wharf, Waterloo-bridge, S.E., and Henley-lodge, Mount Ararat, Richmond, Surrey.

Cheesewright, Frederick Henry, 23, Gower-street, Bedford-square, W.C.

Churcher, George, Bridgemary-house, Fareham.

Coles, Samuel Hood Cowper, Pennegarth, Crickhowell, South Wales.

Cooper, John Nealer, 10, Nelson-road, Ponders-end, Middlesex.

Crowley, Philip, Waddon-house, Croydon.

Dent, Admiral Charles Brayley C., Bryn y Mor Holyhead.

Dowker, George, Stourmouth, Wingham, near Dover.

Ekin, Tom, 12, Little Queen-street, Westminster, S.W.

Fox, Thomas, jun., The Court, Wellington, Somerset

- Glasier, William Richard Minter, 3, The Paragon, Blackheath, S.E.
 Grant, Henry, Sydney Hyrst, Chichester-road, East Croydon.
 Gray, C. H., Lessness-park, Abbey Wood, Kent.
 Gray, William Ernest, India-rubber and Telegraph Works Co., Silvertown, E.
 Griffiths, William, Groby, Woodberry Down, N., and 283, Kingsland-road, E.
 Harman, Alfred Hugh, Langsett, Ilford, Essex.
 Hatfield, Henry, H.M. Patent-office, Southampton-buildings, W.C.
 Hawliczek, Josef L., 99, Ullet-road, Sefton-park, Liverpool.
 Hollyer, Frederick, 9, Pembroke-sq., Kensington, W.
 Hooker, Benjamin, Pear Tree-court, Farringdon-road, E.C.
 Hooper, Cecil H., Pains-hill-park, Cobham, Surrey.
 Hooper, Clarence, Exeter-hall, Strand, W.C.
 Houghton, William, Hoe-st., Walthamstow, Essex.
 Ievers, George M., Inchera, Glanmire, Co. Cork.
 Iser, A. I., Racquet Foundry, St. Bride-street, E.C.
 Jefferiss, Arthur Henry, Claverton, Eliot-bank, Forest hill, S.E.
 Johnson, Sir John Henry, 23, Billiter-street, E.C.
 Jolliffe, Charles Henry, The Brewery, St. Helens, Lancashire.
 Jones, T. Hankins, Kenilworth, King's-road, Kingston-on-Thames.
 Kitto, Thomas Collingwood, Bedford-villa, 20, Marlborough-road, Gunnersbury.
 Laing, Charles Coleman, 16, Kensington-gore, S.W.
 Laing, John, Stanstead park, Forest-hill, S.E.
 Lane, Col. Ronald B., 4, Savile-row, W.
 Mannesmann, Charles, Landore, Glamorganshire.
 Marks, Harry H., Loudoun-hall, N.W.
 Marson, James, J.P., Hill-cliffe, near Warrington.
 Martin, Nicholas Henry, 85, Osborne-road, Newcastle-on-Tyne.
 Maw, W. H., 35, Bedford-street, Strand, W.C.
 Merton, Zachary, 18, Chesham-place, S.W.
 Milne, Admiral of the Fleet, Sir Alexander, Bart., G.C.B., 1, Lowndes-street, S.W.
 Mitchell, A. C., Lubbock-road, Chislehurst, Kent, and 44, Cannon-street, E.C.
 Orchard, John, 100, High-street, Kensington, W., and 27, Hereford-road, Bayswater, W.
 Paine, Charles Cleverly, Cedar-house, 124, Stamford-hill, N.
 Palmer, George William, Elmhurst, Reading.
 Peirce, William George, Riverside, Richmond, Surrey.
 Pochin, Percival Gerard, 13, Ranmoor-park, Sheffield.
 Price, Hall Rokeby, 1, Cowper's-court, Cornhill, E.C., and Hatfield-road, St. Albans.
 Rees, Rev. Samuel David, St. George's Vicarage, Pendleton, Manchester.
 Rew, R. Henry, Norfolk-house, Norfolk-street, Strand, W.C.
 Richardson, William James, Racquet Foundry, St. Bride-street, E.C.
 Roberts, William James, Regent-road, Lowestoft.
 Sax, Alfred Louis, 7, Ridgmount-street, W.C.
 Sax, Charles William, 7, Ridgmount-street, W.C.
 Shaw, James Charles, 35, Leinster-gardens, Hyde-park, W.
 Smith, Major-Gen. Philip, 4, Hobart-place, Eaton-square, S.W.
 Soll, Jorgen Henrick Ferdinand, 204, Croydon-road, Anerley, S.E.
 Somerville, Charles Stuart, 287, Broadway, New York.
 Squire, Henry, 38a, King William-street, E.C., and Heath-view, Hampstead, N.W.
 Stock, Collard Joseph, care of Bradbury, Wilkinson & Co., 25, Farringdon-road, E.C., and Junior Athenæum Club, S.W.
 Stokes, Lieut.-General Sir John, K.C.B., Good Rest, Hayward's-heath.
 Sutcliffe, Frederick William, 248, Rochdale-road, Oldham.
 Sutton, Henry, 1 Farrar's-buildings, Temple, E.C.
 Thomson, David Croal, 116 & 117, New Bond-street, W.
 Thorne, Frederick G., Burntwood-lodge, Wandsworth-common, S.W.
 Tiarks, Henry F., Foxbury, Chislehurst, Kent.
 Toope, Charles, Stepney-square, High-street, Stepney, E.
 Towle, William, 52, Fitzjohn's-avenue, Hampstead, N.W.
 Townsend, E. de Kay, 300, Second-street, Baltimore, Ma., U.S.A.
 Tyler, Rev. William, D.D., Pine-house, Holloway, N.
 Vezey, John Jewell, 55, Lewisham High-road, S.E.
 Willis, William, 49, Palace-grove, Bromley, Kent.
 Wills, John, 16, Onslow-crescent, South Kensington, S.W.
 Wilson, Arthur P., 12, Barkston-mansions, South Kensington, S.W.
 Wood, Collingwood Lindsay, Freeland, Forgan-denny, N.B.
 Wratten, Frederick Charles Luther, 38, Great Queen-street, Long-acre, W.C.
 Young, Maj.-Gen. Charles Becher, 7, Bath-road, Bedford-park, Chiswick.

The paper read was—

THE CHICAGO INTERNATIONAL EXHIBITION OF 1893.

BY JAMES DREDGE,
Member of Council.

The suggestion that a great International Exhibition should be held in the United States two years hence appears to date from the summer of 1889, when the rumour spread that Americans, incited by the brilliant results achieved in Paris, determined that a similar celebration, but one that should surpass in

extent and grandeur the Centennial Exhibition of the French Republic, should be held on the other side of the Atlantic. The year 1892 was selected because it will be the four hundredth anniversary of the modern discovery of the New World, or rather of some of its detached outposts lying to the south-east of Florida. It was on August 3rd, 1492, that Christopher Columbus sailed from Andalusia ; on October 12th following he took possession, in the name of Spain, of the Bahama Isles, and two weeks later of Cuba. It was not, however, until nearly six years later, and in the course of his third voyage, that he discovered the American Continent ; and in this discovery he had been anticipated by Sebastian Cabot, who had been sent out on an exploring expedition by Henry VII. of England, and who was the first to set foot on the American main land ; this was on June 24th, 1497. The choice of dates was therefore at the option of the organisers of the new scheme, and probably for some reasons it would have been preferable to have delayed the celebration until 1897 or 1898 ; that, however, would have been to dismiss the undertaking to a rather remote and uncertain future, and it was decided therefore that it was the first discovery of Columbus which must be celebrated, and that 1892 should be the year during which the commemoration should be held.

What was only a vague rumour floating over the Champs de Mars last year speedily took serious shape, and it became evident that, on or about the date first spoken of, an International Exhibition would be held in America. There can be no doubt that such a scheme is an eminently practical and useful one. Sixteen or seventeen years will have passed since the great Centennial Exhibition had been held in America ; and this long period has been marked by a development of resources, a growth of population, an increase in industry and in riches to which history can offer no parallel. In the United States, the Philadelphia Exhibition of 1876 already belongs to ancient history ; but it is regarded as an epoch from which is dated the commencement of much that was new and good in American taste and culture, notably, as regards house architecture and art publications. The great flood of annual travel from America to Europe had not then set in, and to most of the visitors to Fairmount-park, where the Exhibition was held, the contributions from foreign nations were a revelation. Since that time, of course increased wealth and facilities for travelling

have brought an ever-growing crowd of visitors to Europe ; and the lessons first taught at Philadelphia have been extended year by year, until the adaptive character of the American has assimilated, more and more, European habits and refinements, and the gulf that separated our manners and customs from theirs is growing narrower day by day.

In the United States, decisive action usually follows with great promptness ideas which are favourably received ; in October of last year it was determined definitely, and almost unanimously, that the Columbian Exhibition should be held, and with this determination came the burning question : To what city should be awarded the honour and the responsibility ? The claims of New York, of course, stood paramount, partly because to New York was due the credit of the original proposition, but chiefly for the reason that New York is the metropolis of the United States, the most cosmopolitan city in the world, and the one best known to Englishmen. Situated on the sea, with a harbour that allows the largest ships to moor alongside her wharves, the facility her position offers to visitors, as well as to the goods sent by exhibitors, are unquestionably very great. To the city of New York, indeed, it seemed as though no other town could successfully contest her fitness or her right to the Exhibition of 1892 ; but American rival cities are enterprising and presumptuous, and several others advanced claims more or less reasonably and stoutly maintained. Washington and Philadelphia, St. Louis, Cincinnati and Chicago, all entered the lists. Only one serious opponent remained, however, to New York after the first encounter ; Philadelphia, who had snatched the honours of the Centennial Exhibition of 1876, could not expect a repetition of the same good fortune, which would have stamped her as the exhibition city of the United States ; Washington, beautiful and attractive as she is, is wholly given up to political instead of commercial enterprise, and made no serious effort to gain a privilege that was thrust upon her rather than sought ; St. Louis was too remote, and Cincinnati not large enough for such a responsibility, so in a very short time it became evident that the selection lay between Chicago, a thousand miles inland, and New York. Before matters had been settled thus far, the approval of the Senate and the President had constituted the Columbian Exhibition as an enterprise indorsed and assisted by Government, so that from the beginning its official character was clearly

defined. As much to the surprise as to the indignation of New York, the city of Chicago maintained its claim.

With characteristic enterprise, its citizens had, before the fray commenced, organised a corporation with a large capital. Not that it was intended to degrade the scheme by making it a commercial speculation, but because it was recognised from the commencement that the greater part of the capital necessary for carrying out this enterprise successfully must be raised in the city. Immediately after this had been done, delegates were sent to Paris to confer with M. Berger, and other directors of the French Exhibition just closed, to obtain all such information as would be useful in carrying on the conflict about to commence, and to organise the Exhibition afterwards.

One of the delegates was Mr. E. T. Jeffrey, and the other Mr. O. Chanute, a well-known American engineer. The report prepared by these gentlemen, during their visit to Europe, was very long and exhaustive, and it proved of considerable service in the struggle that afterwards took place at Washington. Of this struggle it need only be said that it was protracted and severe; New York and Chicago were practically the only claimants in the field, and much oratory and cunning argument were put forth on both sides. Probably New York committed the dangerous error of under-rating its opponent; and certainly it had the fatal misfortune of suffering from political internal feuds which of itself was sufficient reason for its losing the contest. In the end, Chicago came out signally victorious; and, on April 25th of the present year, an Act of Congress was approved, providing for the celebration of the "Four Hundredth Anniversary of the Discovery of America by Christopher Columbus, by holding an International Exhibition of Arts, Industries, Manufactures, and the products of the soil, mine, and sea, in the city of Chicago." This legislation, while it constituted the Columbian Exhibition a Government undertaking, pledged the United States Treasury to but little expenditure, although there is but slight reason to doubt that, should the necessity arise, patriotic feeling at Washington, combined with the senatorial pressure from the Western States, would assure a liberal amount of Government aid.

To such an extent is the Exhibition regarded as a Government undertaking, that the Act of Congress above referred to provides that the general control shall be vested in a United

States Commission, composed of two Commissioners from each State and territory, and of eight special members; this body is recognised as the Columbian World's Fair Commission. As a matter of fact, this Commission was appointed in duplicate, so that a reserve force should always be on hand to fill up vacancies. The chief functions of this Commission were to decide upon the site available for the Exhibition; to approve of the buildings and general arrangements; to make allotments of space, to classify exhibits; to determine the plan and scope of the undertaking; to appoint the juries and confirm awards; and to make all arrangements with foreign exhibitors. The actual carrying out of details, and, in fact, the responsibility of the undertaking, falls, however, upon the Executive Committee, which has been formed from the original organisation of Chicago citizens, the Washington Commission being instructed to withhold their assent to any actual steps being taken until the corporation could show that it possessed a *bonâ fide* subscription of at least 5,000,000 dols., of which 10 per cent. was paid up, and a further guarantee of 5,000,000 dols., making in all 10,000,000 dols. to provide for the expenses of construction and management. So soon as formal notification to this effect has been given by the Commission to the President of the United States, he will make proclamation of the fact, and will communicate with the diplomatic representatives of foreign nations, and through them invite their respective Governments to take part officially in the Exhibition. As regards the active participation of the Government as an exhibitor, it is provided that a sum of 500,000 dols. should be devoted to the erection of a Government building, to be filled with Government exhibits, which would be collectively contributed from various executive departments; such as the Smithsonian Institution, the United States Fish Commission, and the National Museum; the control of this collection being vested in a special committee. Another Government exhibit will be the complete reproduction of a first-class life-saving station, of which there are many on the American coast. The President is also empowered under the Act to hold a grand naval review in New York Harbour in April, 1893, and in which the navies of foreign nations will be invited to participate. Besides the foregoing, the American Government makes itself responsible for various other sums, the total authorised outlay being 1,500,000 dols.

The corporation, acting under the general control of the United States Commission, consists of a board of forty-five directors, all of them carefully selected with reference to their influence and standing; of these the president is Mr. Lyman J. Gage, one of the leading bankers in Chicago, and the secretary is Mr. Benjamin Butterworth, who is well and favourably known in political circles at Washington. The director-general, elected only a few weeks since, is Mr. George R. Davis. Out of the body of directors a number of committees were formed; the Executive Committee with thirteen members, and others dealing with finance, grounds and buildings, legislation, national and State exhibits, foreign exhibits, catalogues and printing, transportation, fine arts, mechanical and electrical appliances, and ways and means.

The President of the United States has not yet issued the invitations of participation to foreign countries, because the financial conditions prescribed by the Act of Congress have only been very recently complied with, but it is expected that they will be delivered within a few weeks. It is very confidently asserted that as regards money, the prospects of the Exhibition are absolutely sound. About 6,500,000 dols. have been subscribed by the citizens of Chicago and the various railway companies interested in the undertaking; of this amount 1,000,000 dols. has been actually paid, and the balance is available on call as the necessity arises. It is anticipated that further subscriptions of 1,500,000 dols. under this head will be received. In addition to the foregoing, the city of Chicago is about to issue bonds to a further extent of 5,000,000 dols. This issue was decided on at a special session of the State Legislature in July last. According to law in the State of Illinois, it is illegal for any city or township to issue bonds for a larger amount than 5 per cent. of the assessed real estate valuation of the city. Now the actual debt of Chicago, though only 12,000,000 dols. (about 10 dols. per inhabitant), made it impossible for the municipal authorities to have raised any such sum as they required under the existing law. The vote of the electors, recorded on November 4th last, showed a unanimous approval of the action of Legislature in passing a special measure. The people of Chicago alone have thus subscribed 11,500,000 dols.; it is proposed hereafter to issue further bonds to the extent of 5,000,000 dols., secured by the receipts from visitors. This measure has doubtless been suggested

by the highly successful policy at the Paris Exhibition, which secured, in twenty-four hours, no less than 30,000,000 francs to the Exhibition treasury; what constituted the great charm of this operation to the public was the fact that a lottery was attached to it; but this feature will be absent from the Chicago Exhibition bonds, since lotteries of all kinds are regarded with disfavour in the United States. So far as the first item of capital is concerned—the 6,500,000 dols. subscribed—it is recognised that the amount, if the undertaking turn out to be a financial failure, will be lost, while the 5,000,000 dols. of city bonds will be added to the municipal debt, and gradually extinguished during a term of years. It is too much to expect that the Exhibition will turn out to be so remarkable a success as to repay all the money thus advanced; still, it is hoped, and with reason, that, after the entry bondholders have been paid—with a fair amount of interest yet to be decided on—that a balance will be left in the Treasury. In such an event, the amount will be divided *pro rata* between the city and the various bondholders. The people of Chicago maintain that they are quite prepared to accept the loss of the whole sum, if needs be, being convinced that the glory which will be reflected on their city, and the indirect profits which the Exhibition will bring, will, in the end, far more than repay them for the money lost. But the figures I have just mentioned do not by any means represent the whole of the resources which will be available for Exhibition purposes. In the first place, the United States Government stands committed for an expenditure of 1,500,000 dols.; and, as has been hinted above, the persuasions of Western senators may, in case of necessity, charm far larger figures from the Treasury. There is no doubt that all, or nearly all, of the various States will appropriate large sums for their own exhibits, and, while these will not swell the capital of the Chicago Corporation, they will contribute, in a very large degree, to the completeness of the Exhibition and the beauty and variety of its buildings. The Legislature of the State of California has taken the lead in this matter, by appropriating 1,000,000 dols. for its Exhibition expenses; and in other States the sums to be contributed for the same purpose are now being discussed. The total expenses of the Paris Exhibition last year amounted in round figures to £3,000,000. As the Chicago Corporation has already in sight a sum of nearly £3,500,000 sterling, it will be seen that, making full allowance for the greater

cost of everything in the United States, the financial part of the undertaking is fairly provided for.

One cannot help wondering why a claim was not put forward—when the battle of the sites was being fought—for the village of Niagara; it is difficult to conceive a location possessing more natural advantages than the area around the great Falls. It would have been neutral ground, over which no jealous rivalry would have been wasted, such as that which was so active between the large contending cities; the hearty co-operation of Canada would have been secured; the waterfalls and the rapids above and below would have proved an irresistible attraction to the whole world, compared to which the interest felt in the Eiffel Tower would have been as nothing; the Cataract Company for utilising the water power could have been in operation in 1893, and could have furnished all the power required for driving the machinery in motion and for other purposes. Niagara is not remote from New York, and at the same time it lies at the door of Canada; it is on the direct route to the great west, and has abundant communication in all directions by rail, lake, and canal. The fact that the place itself is but a village, and that the adjacent city of Buffalo possesses only a limited accommodation for visitors, would have been difficulties easily overcome by the enterprising American speculator and hotel keeper. It is true that the powerful local interests which will give the Chicago Exhibition extraordinary scope and vitality would have been wanting; but, on the other hand, it is reasonable to suppose that such a scheme would have been supported by a unanimous national enthusiasm, and with the Falls of Niagara as a leading attraction, would have commanded a universal interest abroad.

It being, however, definitely decided that the Columbian Exhibition of America is to be held in the city of Chicago, it will be both interesting and useful to form some opinion as to the actual advantages of the site, both from a national and international point of view. This question having been settled, it is quite unnecessary to consider whether New York, Washington, or any other city would have been preferable. So far as foreign exhibitors are concerned, it would appear at first sight as though the commercial metropolis of the United States, situated as it is on the Atlantic seaboard, would have offered far greater advantages than those possessed by a city a

thousand miles inland; it must be remembered, however, that facilities for transport are not the only questions which arise in connection with advantages to be derived from taking part in a great Exhibition. The main object of an exhibitor is to bring his exhibits under the notice of the greatest number of probable purchasers, and the people of Chicago claim that their city possesses this advantage in a higher degree than any other town in the United States. Whether this be true or not, it is beyond dispute that Chicago is the great distributing centre of a vast selling and purchasing community, the strength and importance of which is increasing every year.

The capital of the State of Illinois, Chicago is practically the commercial metropolis of the adjoining States of Indiana, Kentucky, Iowa, Wisconsin, and Minnesota, all of them devoted chiefly to agricultural and pastoral industries, the products of which gravitate chiefly towards Chicago and St. Louis. The State of Illinois, which has an area of 56,650 square miles, a length of 385 miles, and a width of 220 miles, is almost wholly prairie land, the greatest elevations not rising more than 900 feet above the level of Lake Michigan; about one-fourth of its whole area is devoted to the growing of corn, and one-sixteenth to the raising of wheat, while over 4,000,000 acres are used as pasture land. Almost the whole State is a vast coal-field, the area of the coal measures being computed to cover 30,000 square miles. There are about 14,000 miles of railroad in operation in this State, representing a capital expenditure of more than £320,000,000 sterling. The gross income earned by this expenditure last year was £12,630,000, the net earnings being 33·10 per cent. of the total. Although figures are uninteresting and difficult to retain, it is worth while to put a few on record to illustrate the railway business in this one State of the Union during last year. The number of passengers carried was 23,755,000, and the average distance travelled was 26·25 miles by each passenger; the cost of carrying each passenger for one mile was 1·721 cents. The number of tons of freight carried was 44,931,095, and the average distance hauled was 98·43 miles, the cost of transport being 5·13 per cent. In this large total minerals take the leading place, the tonnage being about 14,500,000; about 10,000,000 tons represent the product of agriculture transported, 3,500,000 tons the weight of animals, 3,000,000 tons that of lumber, 4,500,000 the tonnage of manufac-

tured articles, and nearly 4,000,000 tons the weight of general merchandise. Of course a considerable portion of this large business found its way to the stock-yards, grain elevators, and wharves of Chicago, which are, moreover, crowded by the ceaseless flow of water-borne freight brought over the great chain of lakes from the eastward, chiefly in the form of general merchandise, or cleared from the city port towards the same direction, in the shape of cereals, meat, and minerals.

The city of Chicago is situated on the southwestern shore of Lake Michigan, and it covers an area of 111,360 acres, or about 174 square miles. It must not be supposed that this vast extent inclosed within the city limits is yet densely inhabited, or even built over. Great tracts of virgin prairie land are included within the boundaries; the extensions of the main streets are laid out across them, but they are innocent as yet of any purpose except that of occasional grazing, or of buildings here and there put up in advance of their time, by enterprising speculators or by persons with a taste for isolated residences. It is urged against the citizens of Chicago by the inhabitants of less rapidly growing American towns, that in their zeal to own the largest city in the world, they will not rest till they have fenced in the entire State of Illinois; but this stricture is hardly just, for if the growth of the population continues at its present rate, another ten years will see the greater part of the spaces now vacant closely built over. At one extremity of the city limits, and included within them, is the suburb of Pullman, once an independent town, the construction of which was commenced nine years ago, and which has to-day a population of 11,000, chiefly dependent on the Pullman Company, which manufactures railway rolling stock on a very large scale. Some idea of the rapid growth of Chicago may be gathered from the fact that ten years ago it was, in importance of population, the fourth city in the Union; to-day it occupies the second place, coming next to New York, with a population of 1,098,576, as compared with 503,185 in 1880; the number of inhabitants has thus more than doubled during the last ten years. This is a far larger increase than can be shown by any other city in the United States, the growth of the population of New York having been only 307,000 during the same period. The following list gives the population of eleven of the principal towns in America, as returned by the census of 1890 and that of 1880:—

	Name of City.	1890.	1880.
1.	New York..	1,513,501	1,206,209
2.	Chicago ..	1,098,576	503,185
3.	Philadelphia ..	1,044,894	847,170
4.	Brooklyn ..	804,377	566,663
5.	St. Louis ..	460,357	350,518
6.	Boston ..	446,507	362,839
7.	Baltimore..	433,547	332,313
8.	San Francisco ..	297,990	233,959
9.	Cincinnati ..	296,309	255,139
10.	Cleveland..	261,546	160,146
11.	Buffalo ..	254,457	155,134

A reference to the tabular summaries of the recent census at the periods above mentioned, shows that this growth is a natural and healthy one, and has not been exaggerated for the sake of effect. The increase in population of the States included in the North Atlantic division since 1873 to the present time is 40 per cent.; that for the South Atlantic division has been 50 per cent.; that for the northern central division, which includes Illinois, and is by far the most populous section of the country, 80 per cent.; in the southern central division the increase has been 60 per cent.; while in the western division, towards which a flood of population has spread, the increase has been 300 per cent.; the total figures, however, in this latter case are comparatively insignificant.

The trade and prosperity of the City of Chicago appear to have increased as rapidly as its population; in 1887 the total value of the commerce of the city was estimated at the enormous sum of 240,000,000 sterling, and since then three years of unusual prosperity must have largely swelled this amount.

The history of Chicago begins in 1811, when the site was occupied by military outposts in constant peril from hostile Indians; and until 1831, by which time life and property had become more secure, it possessed only a few inhabitants isolated from the rest of the world. In February, 1835, the place was incorporated as a town, and two years later it was raised to the dignity of a city, with a population of about 5,000. From that time to the present, the municipal area has been extended seven times; in 1847 and in 1853; then ten years later, and again in 1869, in 1887, in April and in July, 1889. The last annexation of territory was on an heroic scale; previously the area was 44 square miles, but by a vote of the people recorded on June 29th, 1889, the limits were at once extended to include 128.24 square miles additional land, and the great metropolis was by this act endowed with a sudden increase in the population of over 150,000 people. At the

present time, the city extends north and south for a distance of 24 miles, while from east to west it has a width that varies from 4.5 to 10.5 miles. Probably, so sudden and great an increase in a city is without a parallel; and the most curious feature of the consolidation is, that it appears to have been effected without any serious opposition, although by the change six independent municipal corporations, with all their legislative and executive powers, were absorbed, and their separate dignities and responsibilities swept away. It is of course this system of annexation that has contributed largely to the phenomenal growth of the city; but the fact remains that such a growth would have been impossible if the increase in trade and industry had not been equally phenomenal and this increase would have been unattainable but for the vast development of the adjoining States, the trade from which naturally gravitates to Chicago as the centre.

Of the extent and future possibility of the States lying to the west of the Mississippi—and the development of which greatly affects the trade of Chicago—we can form but a very limited idea. The area on the west of the great river is twice as large as that which lies on the east, and of this what is not mineral land is, for the most part, richly adapted for agricultural and pastoral pursuits. The proportions of the Western States are almost beyond one's grasp. Texas could hold the whole population of the United States, and not be more crowded than Germany. Dakota could do the same, and so could New Mexico. The State of Texas alone could produce nearly all the food crops required for the entire country. It could raise more than all the cotton crops, and pasture lands as large as the entire State of New York would still remain. It is estimated that the arable lands of the west cover at least 900,000 square miles. There are 260,000 square miles of timber country; and, in 1880, less than one-fourth of the pasture was occupied with more than 61,000,000 of live stock. It would seem as if the future destinies of the United States must be controlled from the west, the population of which, by natural increase and by immigration, is growing with so much rapidity; where energy appears unbounded, and the wealth of the soil, as of the riches hidden beneath its surface, is inexhaustible. A well-known American writer says:—"The unrivalled resources of the west, together with the unequalled enterprise of her citizens, are

a sure prophecy of superior wealth. Already have some of the young States outstripped their elder sisters of the east in individual wealth. . . . The west is destined to surpass in agriculture, stock raising, mining, and, eventually in manufacturing. . . . Beyond a peradventure the west is to dominate the east. With more than twice the room and resources of the east, the west will have probably twice the population and wealth of the east, together with the superior power and influence which, under popular government, accompany them."*

These sentences, written some years ago, would seem to be already partially confirmed, and if the forecast be too sanguine and enthusiastic, the conviction is nevertheless forced upon the foreign visitor that if the head of the nation lies upon the Atlantic shore, the heart beats in the Middle States, and the sinews and muscles are in the West. Certain it is that some such process of western domination as that described in the lines above quoted is now in progress, and when the mighty struggle comes, as come it must, and that possibly in no very distant future, between protection and free trade, it is in the west that the anti-tariff banners will be unfurled.

To give an idea of the importance of Chicago as a great trading metropolis, it is necessary to have recourse again to figures. The city is the converging point for 30,000 miles of railroads, and it is claimed that 81,000 miles, or nearly half the total network of railways that cover the United States, affect her commerce more or less directly. She is the main centre of the vast trade carried on upon the chain of inland seas which gives her a direct water way to the Atlantic, and places her, if not on a level with, at least only second to, New York as an American port. To her stock yards are brought a daily average of 30,000 head of stock, and with the exception of what is required for consumption in the city, is exported in various forms.

Hogs and cattle, with their various products, grain and ore, form the staple of trade in Chicago, but besides these there are a vast number of imported industries that give employment to about 150,000 workmen; the number of miscellaneous manufactories in the city is about 25,000. During the year 1889 there were received in the city elevators, or on the wharves, 183.5 million bushels of grain and its equivalent in flour; this represents

* "Our Country," by the Rev. J. Strong.

more than one-twentieth of all the grain raised in the United States.

The estimated value of the live stock received at Chicago last year exceeded £40,000,000, and nearly 5,000,000 tons of coal were delivered in 1889, and 650,000 tons were shipped; most of this was brought from the coalfields of Illinois, Indiana, and Ohio.

The steel works of Chicago are sufficiently important to produce a greater tonnage of rails than any other steel centre in the country; in this industry, as in so many others, the position of the city is extremely advantageous, ore being delivered to the works for a freight of only 60 cents per ton, and the rates for coal are also very moderate; the ores chiefly used average about 60 per cent. of iron. With such a large grain trade, storage accommodation on a corresponding scale is a necessity; all, or nearly all, that is brought to the city has to be deposited in the elevators for subsequent transshipment into vessels, railway waggons, or into carts for local requirements. There are altogether some thirty elevators of the first magnitude, the combined capacity of which is 30,000,000 bushels. The largest of these great stores contains 3,000,000 bushels, but the average capacity is less than half this amount.

While it is difficult to obtain figures as to the total tonnage of through freight that arrives at, or is despatched from, Chicago, it may be interesting to note that at least 3,000,000 tons represent the bulk of the traffic passed through the city from various places for consignment without breaking bulk, which is more than 6,000 tons per day.

The lake navigation is, however, the most interesting portion of the transport trade of Chicago, and on this subject very detailed statistics are compiled. The harbour, as well as the whole of Lake Michigan, is placed under the charge of the United States Engineer Department, and, for a number of years, works of more or less importance have been carried on to increase the facilities for shipping and to give relief to the overcrowded river. The outer harbour has an area of 450 acres, about 100 of which are reserved for the future construction of docks and wharves, by reclaiming the foreshore and filling up for a width of some thousand feet, parallel to the existing bank. Outside, the harbour is inclosed by easterly and westerly breakwaters, as well as by a northern pier, all of timber, but it is intended to replace these by stone and concrete. Since the works were commenced, 1,500,000 dols. have been expended on them, and the outer

harbour has been dredged to a depth of 16 feet. The lake navigation is open from the end of April to the beginning of December, so that only seven months are available in the year, although a small number of coasting vessels feel their way along the shore of the lake in spite of the dangers from ice. In the year 1870 there were 12,739 vessels arrived, and 12,433 cleared at the port of Chicago, the total tonnage being about 5,000,000. In 1889 the number of vessels entering the port was 10,804, and that leaving 10,984, while the respective tonnage was 5,102,790 and 5,165,041. Besides the increase in trade which has doubled during the last twenty years, it will be noticed that the larger tonnage was carried in 2,000 less vessels than in 1870, showing an increase in the size of the ships used, which now rises as high as 3,000 tons. It is, of course, to be expected that the lake trade should increase at a very rapid rate, because the freight charges by steamer can always compete successfully with those by rail transit, and thus give to such systems as the Erie Railroad special advantages, because over the greater part of the distance—that between Chicago and Buffalo—goods are conveyed by water.

Chicago possesses but few attractions to the general European visitor; it is a city of perpetual noise and bustle, where the constant roar of traffic and the ever-crowded streets banish all idea of repose. The longest day appears too short for its appointed work, and the whole object of life seems concentrated in the desire to shorten it by wearing it out. The increasing manufactures and population threaten Chicago with the same pall of smoke that rendered Pittsburg a byword till within the last few years, and as it is not probable that natural gas will be found in the vicinity, the problem of smoke consumption is even now one of formidable proportions.

Chicago is laid out with main streets or avenues after the fashion of most American cities, with narrower streets crossing, generally at right angles, a geometrical arrangement that possesses many advantages. The rule has of course many exceptions, rendered necessary in some cases by the intrusion of the sluggish Chicago River and its branches. The streets and avenues are wide, and on a dead level; the principal ones are bordered by vast piles of buildings which are the glory of the citizens and the wonder of visitors. Although the town has an area of 174 square miles, the prices of land in the central portion

rise to fabulous amounts, and rents are dearer than in London; for this reason, and with a desire to possess the highest buildings in the United States, the blocks are run up to twelve, thirteen, and even fifteen storeys in height. In some of these, staircases are regarded as superfluous, and in all of them, elevators, sometimes as many as eight or ten, run up and down all day at express speed. Street railroads of course form the chief means of transit for passengers, and it is in Chicago that the cable system of tramways has found its fullest development; the high speed at which the cars are propelled by this means is counteracted to a considerable extent by the heavy waggon traffic that crowds the ill-paved streets. The concentration of business is naturally greatest upon the branches of the Chicago River and the 35 miles of wharves that constitute the accommodation of the port. The streets crossing the muddy stream and its branches are connected by swing bridges, the constant opening of which, for the passage of ships, causes a continual congestion of traffic. This is avoided in some instances by the construction of tunnels underneath the river. Seven terminal stations, that provide for 21 different railway companies, add to the busy aspect of the city, and the great network of competing lines that concentrate over the suburbs, crossing and recrossing each other on the level, give the visitor a high respect for the superior intelligence of the American engine-driver, who, assisted with only a very crude signal system, contrives to handle an enormous train business with but few accidents and little loss of life. Except for theatres and parks, Chicago may be said to have no means of amusement, for which, indeed, there seems no leisure. Possible visitors to the Columbian Exhibition of the idle class may take this information as a hint that they perhaps had better stay away. Besides the vast business blocks of the city, and the Auditorium-buildings, which contain a giant hotel, the largest theatre in the world, hundreds of offices, scores of shops, and a Government signal station, the pride of the inhabitants lies in their parks, and the suburban dwellings of the wealthy inhabitants, who must be very numerous, if a conclusion can be drawn from the number and appearance of these residences.

A struggle scarcely less severe than that at Washington followed the victory scored by Chicago, and took place within the city itself. This was the battle of the sites, in which all

citizens, and many who were not interested at all, took part with that energy and vehemence so surprising to an Englishman. Railway companies and Park Commissioners, the Government Committee and the local executive, even the United States Engineer Corps, took active sides in the dispute, while the Chicago newspapers, with but little patriotism and less reason, added to the confusion by indiscriminate condemnation. Of course order was evolved out of all this chaos, but not until much valuable time was lost, and more or less mischief done. One of the most lively causes of dispute was the so-called dual site that involved the arrangement of the Exhibition in two localities about three miles apart. Without explanation, this proposal appeared an unpractical one, though in reality it was attended with many advantages, and was in the end very willingly adopted.

Another matter of discussion was as to which of the parks in Chicago should be selected for the construction of the main buildings. Many such parks were more or less well adapted for the purpose, and each site, as it was proposed, found a large number of enthusiastic supporters and an equal number of determined opponents. A large space of land was offered for the purpose by a private owner, and an extensive site close to Lake Calumet was also suggested. Both these latter proposals were, however, soon abandoned, because, though the ground in each case stood within the city limits, they were too remote to be practicable. In the end, a decision was made in favour of Jackson-park, a large and partly reclaimed space of about 800 acres, situated on the lake front, and in the southern part of the city. But it was felt that the space thus given by the South Park Commissioners was insufficient for the purposes of the Exhibition, and efforts were made to secure the smaller and very beautiful Washington-park, lying at some distance away. After many negotiations, a satisfactory arrangement was entered into between the Park Commissioners and the Exhibition executive, by which both Washington and Jackson parks were ceded, as well as a broad connecting strip known as the Midway Plaisance, which connects the two parks. By this arrangement, an area of some 1,200 acres was secured for Exhibition purposes, an extent felt to be amply sufficient, if not embarrassingly large. At the same time that this arrangement was completed, the difficulties that had existed between the executive on the one hand and the Illinois Central Railway Company and

the United States Engineers' Department were satisfactorily adjusted. These difficulties had their origin in the demand of the executive for the cession of a piece of ground on the lake front, situated in Lake-park, in a central part of the city, and an addition to this space, by a reclamation of a portion of the adjacent foreshore. The total amount thus obtained would equal about 80 acres, and was required by the executive for the erection of special buildings. It was this independent space, three miles from Jackson and Washington Parks, which constituted the much debated dual site. But the railway company threatened injunction on the ground of trespass, and the Government Harbour Board forbade the filling up of any portion of the lake, which is national property, so that for a long time it appeared as if the projects of the executive concerning the dual site would have to be abandoned. In the end, however, amicable compromise overcame the various obstacles, and the executive became possessed of the land, and of the power to extend it into the lake, under very favourable conditions.

It forms an important part of the Exhibition scheme to utilise this Park-lake site for the construction of large and possibly of permanent buildings for the display of pictures, and probably for collective exhibits of scientific rather than of commercial interest. It is intended also to add to these as many attractions for the public as can be devised, and that this part of the Exhibition at least shall be kept open at night, for the benefit of visitors staying in Chicago and who may not feel disposed in the evening to go so far as the main Exhibition buildings. The common sense of this proposal will be apparent when it is remembered that Chicago, like all other American cities, is deficient in public amusements and attractions, and it is thought by the Exhibition executive that it would be possible to create special attractions for the public in this small area, similar to those that were so successful in our series of exhibitions at South Kensington—the first condition of success being the creation of serious exhibits to serve as an excuse for attending out-of-door amusements.

Having secured the two large parks of Washington and Jackson, with the connecting strip, the next important question that presented itself was in which of these parks the main buildings should be erected. Washington-park presents the advantage of being

beautifully laid out with great stretches of grass and large plantations of fine trees; Jackson-park has the attraction of being on the lake, so that the Exhibition buildings could be grouped along the shore of the fresh-water sea. This arrangement offers many advantages, such as effectiveness of position, facility of dealing with sanitary questions, a close association of the naval sections of the Exhibition with the main scheme; on the other hand, it involves larger outlays in landscape gardening, and it is more than probable that during some period of the Exhibition the lake storms may prove inconvenient. We believe that, after careful consideration, the lake site has been definitely adopted, and that Washington-park has been preserved for separate pavilions, flower shows, and the like. One of the special features of Washington-park is the racecourse and grounds of a famous Chicago sporting club, and this, with its various accessories, is to be included as a part of the Exhibition. The strip of broad, flat land connecting the two parks has also to be utilised, and its position suggests it as being admirably adapted for conversion into a street of States and Nations. By using it for this purpose, a magnificent perspective of fine buildings presenting many varieties of architecture would result, and the various States and foreign countries taking part in the Exhibition could be provided with ample space for erecting their offices, special pavilions and buildings for entertainment, beside which the famous Rue de Caire would sink into insignificance. Much work for the landscape gardener remains to be done before the greater part of Jackson-park can be completed, but nature has already assisted greatly by forming a number of large lagoons connected with the lake, which can easily be converted into spacious pieces of ornamental water. It is not too much to say that no such favourable site has ever been placed at the disposal of an exhibition executive, both as regards size and beauty; the great dimensions of the grounds will, in fact, not improbably be a source of embarrassment to the management, especially at night, for it is determined that the Exhibition shall be kept open to the public after dark. The efficient lighting of such large spaces presents almost insurmountable difficulties, one of which is the expense that would be involved, and it will probably be found necessary to follow the example set by Paris in dealing with a much more restricted area, and place only a part of the buildings and grounds at the disposal of evening visitors.

Another serious problem which will present itself for solution will be the provision of efficient means of transport within the grounds; this requirement will offer an admirable opportunity to exhibitors of every kind of portable and surface railways, and to every system of traction and motive power. The astonishing success which attended on the little Decauville Railway at the Champ de Mars last year will no doubt be repeated on a much larger scale in 1893, where the necessity for transporting visitors will be much greater.

Objection has been raised that the selected site is too far from the centre of the city; this criticism, however, has no weight. In the first place, the means of transport provided will be ample, and the existing lines of railway running past the south parks can be multiplied; it is in contemplation to construct a special railway for Exhibition traffic; cable-car accommodation can be increased indefinitely, and to provide for the reception of the large number of visitors which the Exhibition will attract, temporary hotel and other living accommodation will have to be provided near the park. Moreover, the road from the city to the Exhibition grounds is a very pleasant one, running along the dead level of the lake shore through Michigan Avenue and the magnificent Drexel and Grand Boulevards. As regards the beauty of its approaches, the Chicago Exhibition of 1893 will also be unrivalled.

Although it is impossible to forecast the nature and extent of foreign participation, a tolerably accurate idea of the most important features of the national exhibits is not difficult to obtain. In mining and metallurgy, in agriculture, in live stock, in agricultural machinery, and in labour-saving appliances, it may be safely predicted that the Chicago Exhibition will stand pre-eminent. Brewing plant will be a distinctive feature, and railway machinery of all kinds will be of the greatest possible interest; educational appliances, the art of producing books, the industrial applications of electricity, and an almost infinite variety of special machinery for working wood and metals, will make this Exhibition of exceptional interest.

The system of classification has not of course been decided on, though it has received very careful attention by the executive. Generally it is intended that a decimal system of arrangement should be adopted, in which the groups should be divided into ten divisions, and each division into ten classes. It is pro-

posed that the arrangement of groups should be as follows:—(1) Agriculture and allied industries; (2) mines and metallurgy; (3) marine and fishery; (4) manufactures and other elaborative industries. This group would include machinery of all classes, the applications of electricity, industrial chemistry, pottery, glass, metal-working, furs and leather, textile industries, paper manufacture, &c. Group 5 would be devoted to food and its accessories, including the production from raw materials, preparation and preservation. Group 6, "The house and its accessories, costume and personal equipment," embraces the arrangement, heating, lighting, ventilation, and water supply of cities; architecture, furniture, dress, jewellery, &c. Group 6 is devoted to the pictorial, plastic, and decorative arts; and Group 8 to social relations and public welfare. The last-named group includes music and musical instruments, medicine and surgery, hospitals and charitable institutions; exhibits relating to property and commerce, labour federations, and the art of war. Group 9 is that of science, religion and human achievement. In this group would be included scientific instruments of all classes, publications, all sorts of ecclesiastical exhibits, and that special branch of educational work of which we know but little in this country, but which is such an important addition to all American churches. Group 10 is devoted to monographic and collective exhibits, a group which the executive appear desirous of encouraging, and of granting to special industries the privilege of taking their exhibits from the groups to which they properly belong, and arranging them separately in different parts of the main buildings or in independent pavilions. There are many obvious reasons why this method of exhibiting should be encouraged, on account of the advantages it offers to manufacturers and to the public. Agricultural and cattle shows will be of frequent occurrence during the Exhibition, and racing and trotting matches will be held constantly. The advantages attending the proximity of Lake Michigan will add greatly to the attractions of the Exhibition, and enable regattas and other aquatic entertainments to be held, and for the same reason scarcely any limit need be set to the importance and variety of the naval exhibits, which it is said are to include a reproduction of the fleet of Columbus.

The object of this paper is only to give some idea of the nature and scope of the coming Exhibition at Chicago, and of the more inter-

esting characteristics and importance of the city in which it is to be held; but it has been by no means the intention to urge the manufacturers of this country to assist in making it an International Exhibition. It would be, without doubt, freely admitted in the United States, that it depends on the action of England whether the undertaking will have to be confined within national limits, or whether it will be aided largely by foreign co-operation. A month ago the universal feeling in Europe was one of resentment against a country that decided, as it seemed wantonly, to close its ports to foreign trade; at present it is one of amazement at the spectacle of a nation that has risen to denounce its lawmakers and to sweep them from the Capitol. But the result of the political cyclone that has devastated the Republican Congress remains yet to be seen, and it must not be hastily assumed that a reaction in favour of free trade has set in; the most that can be expected is that the effort to exaggerate protection, and to benefit eastern manufacturers at the expense of western agriculturists, has been defeated, and that foreigners will continue to find American markets as heretofore. If this should prove to be the outcome of the recent elections, there can be no doubt that the value of these markets to this country will continue to increase rapidly from year to year with the growth in the population and the wealth of the Western States. If it be assumed—and such an assumption appears reasonable—that the voice of the United States has been raised in a successful protest against any increased protection, English manufacturers will be able to judge for themselves how far the expense and trouble of exhibiting will be a justifiable speculation, and, in coming to a conclusion on this point, they should bear in mind that the Exhibition will be held in the great purchasing centre of that section of the continent where the sentiment in favour of reduced tariffs is the strongest. In this place it may be worth while to call attention to a curious though natural result of the McKinley Bill. In anticipation of this obnoxious measure becoming law, American buyers had been for months before purchasing in the European markets on an enormous scale, and at the present time vast stocks have been accumulated, bought under the old tariff. The natural result of this, combined with the social revolution that appears to be at present taking place, but the results of which can have little commercial consequences for many months to come, will in-

crease the stagnation of American foreign trade, since existing stocks will be drawn upon to the utmost, and further purchases delayed as long as possible, in the hope that, before they are exhausted, reasonable counsels will prevail, and disturbed commercial relations readjusted. In such a fortunate event the clogged channels of European trade with America would be cleared, and the volume of foreign commerce westward would be vastly increased. Should this desirable result be achieved within the next eighteen months, it is probable that the Chicago Exhibition will be an international one in a broad sense of the term. But if time bring about a different solution than now appears probable, even should the McKinley Bill be sustained, with all its evil consequences at home and the paralysis of American foreign trade, there would still remain certain branches of English history and art that would distinctly be benefited by being represented at the Chicago Exhibition. In the first place, it must not be forgotten that at these vast gatherings foreign buyers come in crowds, and should Europe abstain from participation, new and valuable business connections will be secured to America that English manufacturers might have obtained; or still worse, existing customers may, and probably will, be taken from us if we are not there to look after our proper interests. Even with prohibitory tariffs, there are certain branches of industry that will continue to command American purchasers. For instance, no amount of protective legislation will enable the United States to approach this country in many departments of art industry. In saying this it must not be forgotten that America has created her own school, but at present the products of that school do not compete. In stained glass, the art products of the loom, in ceramics, high-class furniture, fine table and decorated glass, and in many other arts, this country will continue to hold her own for years to come, and to be the source from which American demands will be supplied; that these demands will continue to increase is practically certain, considering the abundance of money in the United States and the increasing taste for articles of luxury, which is gratified with considerable liberality. In this connection, too, it may be well to remember that the number of Americans visiting Europe augments from year to year—during the season just closed, the total number that crossed the Atlantic was

greater than that which flocked over last year to visit the Paris Exhibition—and that London is rapidly and surely becoming a greater favourite with Americans as a place to visit, and especially as a place in which to purchase, than Paris. The number of American visitors is estimated at from 80,000 to 100,000 annually, and each of them leaves behind him in Europe at least £50; so that some four or five millions sterling—a large proportion of which is spent in purchases—is added to the wealth of Europe every year. On this account, it is reasonable to suppose that English manufacturers who take the risk of exhibiting at Chicago will form lasting and valuable business connections with Americans who take advantage of their frequent visits to this country to make extensive purchases, which they are able to pass into the United States as personal effects, and therefore free from duty. It should be mentioned, that it is the intention of the Exhibition executive to establish, as a part of the undertaking, a vast bazaar, where articles which are shown as samples in the Exhibition buildings can be purchased. Considerable benefit is likely to arise from this arrangement, for everyone knows how the purchasing inclinations of visitors are checked by inability to procure and carry with them objects which may attract their fancy when visiting an Exhibition. Before the time for closing has arrived, the desire for possession has passed, and many valuable, even though transient, customers are lost. It is thus evident that there exist some strong and sufficient reasons for manufacturers to exhibit, even though they have to do so under the disadvantages of a heavy tariff.

But there are other classes of industrials to whom the benefits to be derived from exhibiting are not doubtful. For example, the inventors of machines or processes for which United States patents are held, and which it is desirous to sell, will certainly find the Exhibition a convenient means of drawing the widest public attention to their inventions. English manufacturers, too, who have been forced, under the pressure of prohibitive duties, to establish factories in the United States in order that they may maintain their trade, will obviously find it to their advantage to appear in the English as well as in the American section, in order to impress upon the mass of visitors, who may be also their customers, that the articles they produce in the American factories are identical with those made in their works at home. In like manner,

manufacturers who are hesitating about establishing such branch works in America will be able to form a clear idea of the advisability of such a step, by exhibiting the goods they would propose to manufacture for the criticism and approval of visitors; the outlay and trouble would of course be considerable, but the public verdict they would secure would serve as as an excellent guide to them for pursuing or abandoning their project. It would not be difficult to find other illustrations to strengthen the assertion that the Chicago Exhibition of 1893 may be used by many of our manufacturers for their distinct benefit. The industrial sections of an international exhibition are nothing more nor less than a costly form of advertisement, and, like every other class of advertising, the most important results that follow are indirect. But just as it is useless to advertise in any medium where the goods announced have no interest for the readers, so it is clear that the Chicago Exhibition will be of no service to many classes of manufacturers in this country. Exhibitors of agricultural machinery, of mining plant, of railway machinery (except, perhaps, signalling apparatus), of labour saving devices, of educational exhibits, and many others, would be absolutely thrown away, unless with very rare exceptions, so far as any commercial benefit to the exhibitor is concerned.

As regards the Art Section of the Exhibition, two distinct questions would arise; the first having reference to an art collection worthy of this country, and consisting chiefly of pictures lent for the occasion. Such a course was followed at the Philadelphia Exhibition of 1876 with very satisfactory results; it is obvious that this class of collective exhibit has no reference whatever to commerce, and can only be carried out at a very heavy cost, which may be justified by the desirability of maintaining the credit of British art abroad. The other class of art exhibits has a more commercial object; there are many painters of excellence in this country who find it difficult to obtain and keep so large a number of clients as they desire, and these would undoubtedly find new purchasers in America in spite of the heavy tariffs imposed on paintings. Such an exhibit certainly may not be a representative one, but it would doubtless have the advantage of bringing to many struggling artists in this country a rich and liberal *clientèle*.

Whatever objections there might be to the creation of a British Section in the Chicago Exhibition, there cannot possibly be two

opinions about the advantages which would accrue to visitors from this country. Comparatively few Englishmen have any idea of the wealth and resources of the United States; of the progress and culture of its people in remote regions; of the part which America is destined to take in the near future in the civilisation and commerce of the world.

The Columbian Exhibition will indicate how far America has advanced in industry and invention; a visit to those sections of the United States of which Chicago is the metropolis will give an idea, such as cannot be conveyed by any amount of statistics, of the resources of the country and the rate at which they are being developed by an energetic people. Except in some few branches of industry, the manufactures of the United States have not come into contact with our own in foreign markets, the fostering influences of protection, and the ever-increasing demands of a vast and rapidly growing population, have kept manufacturers busy in supplying home wants. But the time will come—and if a reduction of tariff should be one of the results of the accession of the Democratic party to power, the time will come quickly—when American industry will be stimulated into fierce competition with our own abroad, and our manufacturers will have to enter upon a struggle for supremacy, the severity of which it is impossible to predict. For this reason, to say nothing of the interesting experiences that can be gained, every Englishman who can spare the time and money, should look forward to visiting Chicago in 1893.

Such a visit should, however, be undertaken with the object of work and not of amusement; neither Chicago, and as a matter of fact, no other American city, possesses any of the attractions that Paris offers, but what is lost in pleasure is compensated for by instruction. The recommendations given above apply therefore only to those who wish to gain valuable information by hard work. As to the cost of such a visit, it may be said generally that, apart from the expense of travelling, and if the executive committee succeed in completing their arrangements with the hotel keepers in Chicago, the expense will probably be less than that of a visit to the Paris Exhibition last year. Exhibitors, of course, would have to be prepared to face a larger expenditure; however favourable the arrangements may be for the transport of goods, the long distance that has to be overcome will be costly; labour, too, commands

higher prices than in this country, so that on the whole the cost of exhibiting in Chicago will be greater than that in Paris. Should the Government see fit to appoint a Royal Commission endowed with funds, it is evident that exhibitors will be relieved to a considerable extent, as no charge will be made for space by the Exhibition authorities, who will, moreover, extend to foreign sections the greatest possible liberality as regards the supply of power, lighting, guardianship, local transport, &c.

Whether the Chicago Exhibition of 1893 is to be in reality as well as in name a World's Fair, or the commercial relations of the United States with Europe are such as of necessity to restrict its scope chiefly to the display of national industries and arts, it is evident that the undertaking will be full of the greatest interest to the thoughtful foreign visitor, and a profit to not a few British manufacturers.

DISCUSSION.

Sir H. TRUEMAN WOOD said there was not much which any one could add, in the way of information, to the paper, but the question which naturally arose was what part would this country take in the Exhibition? He had had many inquiries as to whether it would be desirable for English manufacturers to exhibit; but that was a question which every one must decide for himself. As had been put very plainly by Mr. Dredge, there were large classes to whom it would evidently be a great advantage to extend their American connection, and there were other classes in whose case one could see little benefit to be derived. But there was a wider and more statesmanlike view than that of mere personal interest; it surely was to the advantage of every nation to be on friendly terms with all other nations. Nations were but aggregations of individuals, and the more those of one nation came in contact with those of another the more friendly they would be. In the case of the Paris Exhibition, political reasons rendered it very difficult for the English Government to take any part, and the unofficial committee which took upon itself to do its best in the matter really deserved the gratitude of the nation for endeavouring to make up in some way for the want of official action. He knew that it was a great satisfaction to the French that England was represented in Paris, and in the same way it would be a source of gratification to America if England took a part, and especially if she took an official part in the Chicago Exhibition. It was of course obvious that a very large number of Americans regarded England with the same feelings of affection with which we as a whole regarded our cousins on the other side of the Atlantic, but on the other hand there was a large

party in America who did not share these friendly feelings, but felt, in fact, very bitter against this country. But the more we could enter into American projects, and help on any national movement they might take in hand, the more would the feeling of friendship be cultivated, and that of animosity overcome. If this Exhibition became really international, he hoped this country would be represented officially. No one knew better than he did the difficulties which unofficial committees and commissions had to encounter. He should never forget the kindness which was shown the English Commission in Paris by Lord Lytton, but he could only do so individually as Lord Lytton, not as the English Ambassador, and in that way alone the Commission lost a good deal of influence, and he could not help contrasting the hard work they had on many occasions with the ease and smoothness with which things worked on a former occasion when the Prince of Wales was at the head of the Commission, and Sir Philip Cunliffe-Owen was its active and energetic officer. He hoped that although there were many cases in which it might be worth the while of individuals or firms to exhibit, some way might be devised by which great centres of industry might be represented collectively. The Manchester Chamber of Commerce, for example, might find it worth while to take steps to ensure that cotton manufacture was represented, although individual cotton spinners might not feel justified in incurring the expense; and so with Sheffield, Birmingham, and other manufacturing towns. He hoped they might look to the patriotism of the country to see that if the country was to go abroad she should be worthily represented, even if it did not pay directly and immediately. If England did not avail herself of this opportunity for an advertisement, other countries would not be slow to do so. If the cotton spinners of Manchester did not exhibit, those of Belgium, the north of France, and elsewhere, probably would, and then England would suffer in the estimation of the world. A Commission need not be so costly an affair as some had been in days gone by. The Paris Committee had shown that it was possible to run a section respectably with very little aid, and make it self-supporting. All that Government need be asked for was the benefit of the national influence, protection, and support, and for a moderate subsidy, which might enable the country to be represented in those branches, such as education, science, and art, in which it could not possibly pay individuals or even groups to exhibit. Either individually or collectively, the commercial classes ought to be able to find the money for commercial exhibits, but the country might be called upon to defray the cost of those non-commercial exhibits from which no profit could be derived. He complimented Mr. Dredge on the admirable way in which he had brought together a vast amount of very valuable information, which he was quite sure would be very serviceable to large classes in this country. He had treated the matter

very fairly and impartially, pointing out both the classes which would gain from taking part and those which would not.

Mr. J. S. JEANS said he had been recently both in Chicago and New York, and had heard a great deal about this Exhibition. In the latter place the people declared it would be a *fiasco*, while in the former they all declared it would be the finest Exhibition ever held. He believed the McKinley Bill, and the great uncertainty in connection with all tariff matters, would seriously imperil the success of the Exhibition as regarded Europeans. He did not think the iron and steel industry would be represented to any large extent. They did not send to the United States any considerable quantity of iron or steel, except tin plates, and one of the main objects of the McKinley Bill was to exclude tin plates altogether from the American markets. There seemed to be a strong determination on the part of Americans to manufacture everything for themselves, and unless that impression were removed, he feared the assistance Mr. Dredge had bespoken for the forthcoming Exhibition would be largely withheld. Something would also have to be done to facilitate the Custom-house arrangements, of which he had had some experience recently, and nothing could be more abominable than the way in which one was driven about from pillar to post in the effort to get articles through which were never intended to be sold or disposed of in any way. He spent nearly a whole week in this way, and only succeeded at last by bringing strong pressure to bear on the authorities, even after the duty had been paid. If that sort of thing went on, the Exhibition would be likely to do more harm than good. On the other hand, the Chicago people were the most enterprising on earth, and nothing struck him more than their extraordinary energy. The best evidence of that was the fact that in the year 1889 alone the number of houses built was exactly half the total number destroyed by the great fire. He was sure nothing would be wanting on their part to make the Exhibition a success.

Mr. C. M. KENNEDY, C.B., remarked that the part which the Society of Arts had taken in former Exhibitions rendered this paper and the discussion particularly appropriate; but until a formal invitation had been given to foreign countries to take part nothing definite could be said as to the course to be adopted. Whatever body superintended the organisation of the British Section would have to depute the practical work to a special commission or committee, and upon that committee no doubt gentlemen would be placed who had had experience in previous exhibitions, as well as manufacturers and exhibitors themselves. If it should fall to the Society to undertake in any way the organisation of that commission, they might be quite sure from past experience that the national interests would be well safeguarded.

Mr. KOHLSAAT said, though he came from Chicago, he was not present in any official way as representing either the city or Exhibition. He of course felt great interest in the matter, and was sure that before 1893 some of the difficulties which had been alluded to would be removed. If the last election meant anything, there were many articles which might be sent from England which would amply repay exhibitors, and whatever the outcome might be, if the Government did not see fit to do anything, he wished to thank the Society for the kind attention they had given to the subject. The paper contained a great many statistics, especially referring to population, which had not been read, which he hoped would be read when it was published. Many people thought that all the population in America centred round New York; but it would be found that, while the population within 500 miles of that centre was 17,000,000, within 500 miles of Chicago it numbered 22,000,000. That showed the great advantage to foreign exhibitors of bringing their goods right to the people. They would be taken all the way in bond, and would not have to be touched until they arrived at Chicago.

Sir FREDERICK BRAMWELL, Bart., F.R.S., said he had no particular knowledge of Chicago, not having been there since 1853, when it was a very different place to what it was now. It was his fortune to preside over the Inventions Exhibition, and he had found that duty so onerous that, ever since, he had rather avoided the subject; and notwithstanding the cordial invitation of Sir Henry Trueman Wood, who promised to look after him, he did not even visit the Paris Exhibition. This one at Chicago would no doubt be of an extremely interesting character, and if energy, determination, intelligence, and lavish expenditure of money would make a success, it would certainly be successful. The question whether it would be to the interest of English manufacturers to exhibit there they must decide for themselves, but he quite agreed with Sir Henry Wood that there was no reason whatever—as there was at Paris—why the English Government should not recognise the Exhibition officially; it was very desirable, whatever might be done by private exhibitors, that the Government, when invited, should give its official stamp to it. It would not only please the Americans, but would afford a considerable stimulus to individual exhibitors, and lead to a larger representation than would otherwise take place.

The CHAIRMAN said he agreed with what had been said as to the importance of official recognition. So far as the trade interests of the country were concerned, if they were to be represented at all in this exhibition, which would be far in advance of anything of the kind which had taken place in America before, we ought to be represented as a nation, and under the auspices of the Government of the day.

Undoubtedly we shall be in a better position in 1893 than ever before; there was a better organisation amongst the various trades, trade literature was more developed, and there was every opportunity of appealing to the public spirit of really representative men in the various industries to come forward at the request of the Government and do their best to see that Great Britain was properly represented. To a great extent we exhibited for the purpose of promoting our own interest; but independently of that, he trusted that there was still alive in England the desire to show other nations of the world that we were not behindhand, that we were not yet beaten by our children, and that we could hold our own at present as well as we could forty years ago, when, in 1851, we were, by common consent, admitted to be far in advance, except in certain special matters, of all other commercial nations. He could understand that, from a pecuniary point of view, there would be an unwillingness to support the Exhibition, in consequence of the McKinley tariff; but, even assuming that no change was likely to take place—which was hardly probable—he hoped the feeling of annoyance would not be allowed too much weight. He did not look upon it at all as simply a question between England and America. Chicago would be largely visited by representatives of other nations, less developed and less advanced than the Americans themselves, who would regard Chicago as the centre of western civilization, and go there to widen and extend their own knowledge. Persons interested in commerce would come from countries to the west of America, especially now there were rapid means of communication across the continent from South America, and from other countries, with whom we had the most friendly relations, to say nothing of Canada. It would, therefore, be most unwise for British manufacturers to let any feeling of jealousy or resentment prevent them from showing, in the best possible way, what they could do. To let it be supposed that they were not willing to exhibit because, in some matters, the actual trade relations between the United Kingdom and America were not on the same footing as they were before the passing of the McKinley Bill, would be like cutting off one's nose to spite one's face. The way to show that England was in many branches supreme, would be to show what we could do in a public-spirited way, even if we did not derive as much pecuniary benefit from it as we otherwise might have done. He had received so many kind and pressing invitations from America, that he feared if he went there he should never get back again; and he could not help thinking that from the pleasure and instruction which would be derived—the making of friendships, and drawing closer together ties of friendship already existing, which did so much to cement nations as well as families together—a visit to such an Exhibition must be of the greatest possible advantage, and that any points of difference

which might arise from the new tariff were more likely to disappear by free communication than by holding aloof. We might fairly appeal to the commercial and manufacturing interests of the kingdom not to allow the appearance of the old country on such an occasion to be in any way unworthy of what she had done in the past; and he was sure the Society would rejoice if by any means they could aid in making the Exhibition a success.

Mr. DREDGE, in reply, said he thought Sir Henry Wood had scarcely done justice to the hospitable character of the Americans, and the warmth of feeling which seemed to actuate them all where Englishmen were concerned. There were of course some ignorant people who looked on Englishmen as their mortal enemies, but on the whole it would be difficult to find a single intellectual American who was not willing to come three-quarters of the way across the Atlantic with outstretched hands to meet us if we would go the other quarter. Mr. Jeans spoke very justly about the difficulty there would be in inducing iron and steel manufacturers to exhibit; it was most unlikely that they would do so unless they were interested in some special branch, for the simple reason that the majority of them knew that we were far behind Americans in the same line of business. They had larger outputs, and more efficient processes for making a large output, and we should have to learn from them rather than teach. Mr. Jeans had spoken with some warmth from his personal experience of the Custom-house difficulties; but he advised him, next time he took the responsibility of personally conducting 400 or 500 Englishmen on a visit to America, to insist on them not carrying hat-boxes, for he believed they caused all the trouble. Two or three reception Committees informed him that they did not mind any amount of trouble, and could deal with any amount of luggage, but when they saw a row of 400 hat-boxes it flattened them out completely. Sir Frederick Bramwell had referred to the qualities of energy, determination, and so forth as a source of success to an Exhibition, and certainly those qualities were more concentrated in Chicago than in any other city. He was sorry Mr. Kohlsaas had not given them more information, as he might have done, being a member of the Exhibition executive; for he had that morning showed him a telegram from the President and Vice-President stating that the United States Commission had fully approved the plans which had been prepared, the sites and financial position, and were about to recommend the President of the United States to issue the proclamation inviting all foreign nations to contribute. It had come to his knowledge that China and Japan intended to be represented on a scale they had not hitherto attempted. This was not surprising in the case of Japan; but the intention of China to come forward in this way was very significant, being another proof of her intention to break down the barriers which separated her from

the western world; so that she would become, in the near future, one of the most valuable foreign markets. The South American Republics had also announced their intention of exhibiting on as large a scale as in Paris. Possible exhibitors would not require to decide for some months to come, and if this paper supplied them with any material for preliminary consideration, he should be amply repaid.

The CHAIRMAN, in proposing a vote of thanks to Mr. Dredge, expressed the hope that when the scheme was more matured, a further paper, giving more detailed information, might be prepared and read.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

CULTIVATION OF HEMP IN ITALY.

The French Consular Agent in Bologna says that the Piedmontese hemp, which has always had a good reputation, is cultivated to the south-west of Carmagnola, on the banks of the Po, which at this point separates the arrondissement of Pignerol, belonging to the province of Turin, from the arrondissement of Saluces, which belongs to that of Coni. The maximum product is 1,000 kilogrammes per hectare (hectare = 2.47 acres) in the communes of Pancalieri, Vigone, Villafranca, Casalgrasso, and Polonghera. At the beginning of the present century the Piedmontese hems were the only ones exported from Italy, and it has been the custom to retain the name in trade ever since the Bologna hemp came into use. In Emilia the main cultivation of hemp extends to the east of the Panaro, between the Po and the Appenines, over the four provinces of Bologna, Ferrona, Ravenna, and Forli. The extent of this cultivation has never been accurately ascertained, but the Chamber of Commerce of Bologna has estimated that in that province alone the hemp harvest amounted in 1879 to 138,806 quintals, and in 1880 to 163,730 quintals. No returns have been published since, except for 1889, when the estimate was 126,063 quintals. The product of the province of Ferrara is about half as much again. Twenty years ago the Neapolitan farmers adopted hemp to take the place of madder. At the present time, the provinces of Naples and Caserta produce about 200,000 quintals. The total product, therefore, of the nine provinces of Italy which are engaged in this cultivation, with the addition of Sicily, may be estimated at 850,000 quintals annually. The export was never more than

600,000 quintals, and is now reduced to about 400,000 quintals. In the two regions of the Po, hemp is grown in biennial rotation with cereals. The hemp fields there are established on alluvial soil, which is rich, deep, light, and fresh. The hemp fields of Naples are more exposed to drought; and in them the soil is prepared with the spade, instead of, as in Piedmont, with the plough; it is gone over twice, the first time very deeply. In Naples several manures are used; dung from the stable, sweepings of the city, leguminous plants, and specially the lupin, either green, or in the droppings of sheep; in Piedmont, no manure is used but from the stable. In Piedmont, in March, about a hectolitre of hemp seed is sown at random over each hectare. The young plants are thinned out, and two successive weedings take place. In the Bologna district, not more than 70 are sown to the hectare, and the seed from the same soil is used, refreshed occasionally with seed from the Carmagnola. In the Naples district nothing is used but Bologna seed, which is renewed every year, experience having shown that a rapid degeneration takes place in the seed obtained on the spot. In Piedmont the hemp grows to a height of four metres; in Bologna, five metres and over, with less thickness at the base. In Naples it rarely exceeds two metres. In the latter district the growth of the hemp is protected by trees and vines, which separate the fields in the old Campanian manner, and are commonly trained to follow the movement of the sun. The process of soaking is usually performed in Piedmont in raiting pools fed by running water. In the Bologna district the raiting pools are in still water, and stones are used to keep the hemp submerged. Around Ferrara stones are often wanting, and the lumps of earth which are used instead make the water muddy, and thus injures the quality of the product. In Romagna there are no raiting pools, and the watercourses are used, to the detriment of their purity. In Bologna the mud of the raiting pool is considered to be a good manure to cover plants fit for fodder with. In Naples all hems used to be taken to the Lake of Agnano, the waters there giving them a beauty and a suppleness which made up for the expense of transport. The drying up of this lake gave a temporary check to the cultivation of the hemp, but now it is taken to the Lake of Acara, the sulphurous waters of which favour the bleaching more than the softening of the rind. There were at one time in the suburbs of Ferrara two steam factories for the preparation of hemp without soaking, but the produce of these factories was everywhere rejected, as it was found they were liable to subsequent fermentation, and at the present time no hemp is prepared except by soaking. The Bolognese hemp is reported as being the most beautiful in Italy. It is almost white, with a shade of grey. It is supple, soft, tenacious, brilliant, and easily divided. Its filaments are slightly curled, it is very elastic and not brittle. It weaves very well especially when moistened. This type is produced all over the pro-

vince of Bologna, especially towards Budrio, as well as at Faenza (province of Ravenna), at Cesaria (province of Forlì), and around San Cesario (province of Modena). The hems of the province of Ferrara, those of Finah (province of Modena), those of Lugo and of Massalombarda (province of Ravenna) are ropemakers' hems. Returns show that the cultivation of hemp is especially remunerative in the Naples district, and it is extending there every year, while at Bologna it is stationary, and in Piedmont is diminishing.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

DECEMBER 10.—F. BAILEY, "Electric Lighting Progress in London." SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

DECEMBER 17.—GEORGE DAVISON, "Impressionism in Photography." PHIL. R. MORRIS, A.R.A., will preside.

Papers for which no dates have as yet been fixed:—

"Methods and Processes of the Ordnance Survey." By COLONEL SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S.

"Lands available for Colonisation." By E. J. RAVENSTEIN.

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"Photography in Aniline Colours." By A. G. GREEN, C. F. CROSS, and E. J. BEVAN.

"The Use of Petroleum in Prime Motors." By WILLIAM ROBINSON.

"Illustrated Journalism." By CARMICHAEL THOMAS.

"The Growing Need for Decimal Coinage, Weights, and Measures." By T. EMERSON DOWSON.

"Sgraffito." By HEYWOOD SUMNER.

"Glass Painting." By H. ARTHUR KENNEDY.

"Electricity in relation to the Human Body." By H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D.

"Steam Lifeboats." By J. F. GREEN.

"The Sources of Petroleum." By WM. TOPLEY, F.R.S.

"The Proposed Irish Channel Tunnel." By SIR ROGER LETHBRIDGE, M.P.

"Milling Machinery." By J. HARRISON CARTER.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at Half-past Four o'clock:—

January 20; February 17; March 17; April 21; May 5, 26.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday afternoons, at Half-past Four o'clock:—

January 22; February 26; March 12; April 9, 30; May 28.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 27; February 10; March 10, 24; April 14; May 12.

CANTOR LECTURES.

The following Courses of Cantor Lectures will be delivered on Monday evenings at Eight o'clock:—

Prof. VIVIAN B. LEWES, "Gaseous Illuminants." Five lectures.

LECTURE III.—DECEMBER 8.—Carburetted coal gas—(a) By volatile hydro-carbons. The alcohols and Maxim-Clark processes—(b) By utilising those constituents of tar which can be converted by heat into permanent gases—The Dinsmore process—(c) By oil gas—The Tatham gas.

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

January 26; February 2, 9.

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

February 16, 23; March 2.

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

March 9, 16, 23.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

JUVENILE LECTURES.

Two Lectures, suitable for a juvenile audience, will be delivered by E. B. POULTON, M.A., on "Mimicry in Animals," on Wednesday evenings, December 31, 1890, and January 7, 1891, at Seven o'clock.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 8... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "Gaseous Illuminants." (Lecture III.)
Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 6 p.m. Mr. Carrington Smith, "The Management of a Herd."
Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned discussion on Mr. T. A. Dickson's

paper, "The Labour Question as regards Agriculture."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. W. Seton-Karr, "Explorations in Alaska and N.W. British Columbia."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m.

Prof. C. V. Boys, "The Heat of the Moon and Stars."

TUESDAY, DEC. 9... Society of Architects, St. James's-hall, Piccadilly, W., 7½ p.m. Mr. A. W. Rimington, "Suggestive Points of Contact between Architecture and Painting."

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 5 p.m. Annual General Meeting.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. E. W. Stoney, "The New Chitturati Bridge, Madras Railway." 2. Discussion on Mr. F. E. Robertson's paper, "The Lansdowne Bridge over the Indus at Sukkur."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. The Hon. Lady Welby, "An Apparent Paradox in Mental Evolution." 2. Mr. Francis Galton, "Exhibition of Patterns of Finger-marks."

Colonial Inst., Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. Edward Greville, "The Aborigines of Australia."

Horticultural, Drill-hall, James-street, Victoria-street, S.W., 1 p.m.

WEDNESDAY, DEC. 10... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. F. Bailey, "Electric Lighting Progress in London."

Geological, Burlington-house, W., 8 p.m. 1. H. J. Marten, "Some Water-worn and Pebble-worn Stones taken from the Apron of the Severn Commissioners' Weir erected across the river at Holt Fleet, about eight miles above Worcester." 2. Prof. E. Hull, "The Physical Geology of Tennessee and adjoining districts in the United States of America." 3. Mr. R. Lydekker, "Certain Ornithosaurian and Dinosaurian Remains."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Shelley, University College, Gower-street, W.C., 8 p.m.

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

THURSDAY, DEC. 11... Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m.

Prof. R. K. Douglas, "Our Commercial Relations with China."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Annual General Meeting. 2. Adjourned Discussion on papers by Prof. W. E. Ayrton, Messrs. C. G. Lamb, and E. W. Smith, "The Efficiency of Secondary Cells," and "The Chemistry of Secondary Cells."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, DEC. 12... Astronomical, Burlington-house, W. 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. Mr. W. G. Boswell-Stone, "The History in Henry VIII."

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. Shelford Bidwell, "Some experiments with Selenium Cells." 2. Mr. James Swinburne (i) "Note on Electrolysis," (ii) "Alternating Current Condensers."

SATURDAY, DEC. 13... Botanic, Inner Circle, Regent's-park, N.W., 3¼ p.m.

Journal of the Society of Arts.

No. 1,986. VOL. XXXIX.

FRIDAY, DECEMBER 12, 1890.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, December 31st and January 7th, by E. B. POULTON, M.A., on "Mimicry in Plants."

The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. Tickets are now in course of distribution, and members requiring them should apply at once.

CANTOR LECTURES.

Professor VIVIAN B. LEWES delivered the third lecture of his course on "Gaseous Illuminants," on Monday evening, 8th inst.

The lectures will be printed in the *Journal* during the Christmas recess.

APPLIED ART SECTION.

A meeting of the Committee of the Section was held on Tuesday, 9th inst., at 4 p.m. Present: Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., in the chair, G. A. Audsley, F.S.A., Charles Barry, B. Francis Cobb, Lewis F. Day, J. Hunter Donaldson, J. Starkie Gardner, C. M. Kennedy, C.B., A. Lazenby Liberty, F. Buxton Morrish, Hugh Stannus, and Thomas Wardle, with Sir Henry Trueman Wood, Secretary of the Society, and H. B. Wheatley, Secretary of the Section.

The programme of papers to be read during the present Session was discussed.

FOREIGN & COLONIAL SECTION.

A meeting of the Committee of the Section was held on Wednesday, 10th inst., at 4.30 p.m. Present: B. FRANCIS COBB, in the

chair; Hyde Clark, C. M. Kennedy, C.B., with Sir Henry Trueman Wood, Secretary of the Society, and E. Cunliffe Owen, C.M.G., Secretary of the Section.

The programme of papers to be read during the present Session was discussed.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 10th, 1890: SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Boyle, Courtney, C.B., Board of Trade, Whitehall-gardens, S.W.

Collum, George Ashbury, Cannon Brewery, St. John-street, Clerkenwell, E.C.

Cundall, Frank, Lyndhurst-house, Wallington, Surrey.

Pearce, Edward Toplis, 22, Hyde-road, Hoxton, E. and Junior Constitutional Club, S.W.

Speirs, Edwin R., Dartmouth-chambers, 8, Theobald's-road, Gray's-inn, W.C.

Wharton, James, Edge-hill, Netherhall-gardens, Hampstead, N.W.

The following candidates were balloted for, and duly elected Members of the Society:—

Birkbeck, Henry, 34, Southampton buildings, Chancery-lane, W.C.

Bostock, George Henry, Hatfield, Yorkshire.

Doubleday, William Bennett, 123, Tulse-hill, S.W.

Ebb-Smith, Joseph, Worcester-house, Walbrook, E.C.

Few, William Resbury, Oaklands, Southfields, Wandsworth, S.W.

Levy, George Collins, C.M.G., National Liberal Club, S.W.

Lucas, Charles Phipps, The Elms, Mottingham, Eltham, Kent.

Pope, Henry R., 34, New Bridge-street, E.C.

Roberts-Austen, Prof. William Chandler, C.B., F.R.S., Royal Mint, E.

Ruffer, Marc Armand, M.A., M.D., B.Sc., 27 Torrington-square, W.C.

Woolcombe, Robert Lloyd, LL.D., 14, Waterloo-road, Dublin.

The paper read was—

ELECTRIC LIGHTING PROGRESS IN LONDON.

BY F. BAILEY, ASSOC. M. INST. C.E.

The last paper on electric lighting read before the Society was by Mr. R. E. B

Crompton, in 1888, when he placed before you some of the difficulties and obstacles which were retarding the progress of electric lighting. The rapid progress made within the last eighteen months will, however, show that these difficulties have, to a great extent, been removed by a number of supply companies having obtained Parliamentary powers to lay mains within certain specified areas into which London has been divided. I propose, therefore, to place before you, in general terms, the work done and in progress by the various companies, as the time at my disposal will not permit me to give minute details of generating stations and systems.

Although the development of electric lighting has been so rapid within the last ten years, it must not be forgotten that the arc light was shown at the Royal Institution in 1809, and remained a scientific curiosity until 1848, when Staite gave a public exhibition of his arc lamp from the portico of the National Gallery in Trafalgar-square. The *Illustrated London News* of that time contains a drawing of the scene, with the following remarks:—"The electric light possesses no novelty. Year after year it has been exhibited at every course of philosophical lectures since the time of Sir Humphry Davy, and therefore really its practicability forms the whole subject for consideration." The electrical energy for this light was obtained from a primary battery; and it is probable that the practicability of this method of obtaining light will continue to remain a subject for remote consideration. At this time, the seed sown by Faraday's discovery, in 1831, of electromagnetic induction, had fallen on fruitful soil; and the wonderful dynamos of to-day form a suitable monument to his genius.

You will see, therefore, that electric lighting commenced its career in London, and London ought, therefore, to show the greatest progress. The incandescent lamp, in some form or another, is mentioned almost yearly from 1836 onwards, and I propose at once to jump to the period when Swan in England and Edison in America brought out the present form of lamp.

Through the kindness of Mr. J. W. Swan, I have the honour to show you the first lamp he made. It is to be hoped that this lamp will eventually come under the care of one of our great museums, in order that future ages may recognise the genius of Mr. Swan.

I have also to thank Mr. Sydney Morse for the loan of another valuable historical lamp.

this being the first lamp constructed by Edison.

Time does not permit me to trace the history of the incandescent lamp, or the extraordinary development of its manufacture. Nothing could have been done practically without the mercury pump, and we ought, therefore, to place the inventor, Dr. Sprengel, in a high position on our records of pioneers.

Turning to the record of general distribution of the electric light in London, you all know that practically nothing was done under the Act of 1882, but private enterprise provided fields for encouraging the efforts of the electrical engineer, and foremost amongst these must be mentioned the Grosvenor Gallery station, which did such good service in making the capabilities of the light known, and in proving the absolute necessity that existed for it; for however defective the supply may have been towards the close of the existence of the station (owing to the plant being overloaded), we owe a debt of gratitude to Lord Crawford for his energetic support to this enterprise, and to those who worked so hard to bring it to perfection. Mr. Ferranti, and those who worked with him at the Grosvenor, laid the foundation-stone of a satisfactory transformer system, and as they had no Parliamentary powers to lay down underground mains, overhead lines were run in all directions. The perfection to which they brought the details of overhead construction is so fully proved by the absence of accidents that it is much to be regretted that the overhead conductors in the United States were allowed to have been put up with no regard to common sense or safety.

It is frequently stated that the Electric Lighting Act of 1882 did much towards stifling inordinate speculation, but in attempting to make people wise by this Act of Parliament, a very serious check was placed upon the development of electrical progress.

The enormous strides which have been made under the more encouraging Electric Lighting Act of 1888 will convince everyone that it was urgently required, and electrical engineers fully realise what they owe to Sir Frederick Bramwell for his share in framing this Act. One of the consequences of this Act was a deluge of applications for provisional orders. A court of inquiry was therefore ordered by the Board of Trade, who appointed Major Marindin as their inspector for this purpose.

If you carefully read the eighteen days' evidence given, you will probably be convinced

that every system was the best. The inquiry lasted several days, and resulted in the granting of provisional orders, confirmed by Parliament in August, 1889, to the companies mentioned in the summary on page 54, which also includes other information.

I must here gratefully acknowledge the very cordial assistance which the engineers of the various companies have given me.

We will now very briefly go round the stations of the companies, commencing with

THE KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHT COMPANY.

This company commenced work under the name of the Kensington Court Electric Light Company in the autumn of 1886, and under Mr. Crompton's able guidance made such rapid progress that they commenced to supply current in January, 1887, using underground mains and running their plant in a temporary building. The Board of Trade license under which the work commenced, being incorporated in the company's provisional order of 1889, which authorises them to supply a portion of the parish of Kensington, St. Mary Abbot, and the detached portion of the parish of St. Margaret, Westminster.

The direct current is employed in conjunction with "Howell" secondary batteries, the pressure being 200 volts on the 3-wire system, with 100 volts in the houses.

The batteries are charged at any convenient time when the engines have power to spare, and not only act as a sponge, which can be squeezed when the engine plant requires assistance, but also act as regulators, as well as maintaining the supply during the hours of minimum demand. The satisfactory use of secondary batteries in this manner has attained its present development mainly through the indefatigable labours of Mr. J. C. Howell.

Two generating stations are erected, one at Kensington-court, and the other at Chapel-place, Knightsbridge, the plant consisting of "Babcock and Wilcox" boilers and exhaust steam feed water heaters, "Willans" compound engines combined direct with Crompton dynamos and "Howell" batteries in both stations. There is also a battery station situated near the centre of the Kensington district at Queen's-terrace-mews, where two large "Howell" batteries are placed. In all cases ample space is provided for the future extension of the plant when required. Arrangements are provided on the Kensington-court station switchboards to enable any dynamo to

be used for charging the distant battery station, to which a pair of charging mains are laid. Mr. Crompton also designed for this company a system of mains of considerable novelty, which was severely criticised at the time, but has since proved most satisfactory.

Culverts constructed with concrete or brick-work are laid under the pavements, and bare copper conductors, supported at intervals by glass insulators, are placed in these culverts. The conductors are composed of copper strips 1" by $\frac{1}{4}$ ", laid one over the other so as to make up the total section required. In cases where there is no room under the pavement in which to build up the culvert, wrought-iron gas tubing is used, and cables insulated with thick vulcanised rubber are drawn through and connected to the bare conductors. Numerous service boxes are fixed in the pavements to enable houses to be connected without opening the ground. Four and a half miles of pipes with cables have been laid. The general route of the mains is indicated on the map on the wall.

On the 1st December, lamps were connected to an equivalent of 24,850 32-watt lamps, and Mr. H. W. Miller, the company's engineer, to whom I am indebted for these particulars, informs me that the lamp supply, or maximum number of lamps in use at one moment, is between 30-40 per cent. of the lamp connection.

THE HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY.

This company, as you see on the map on the wall, covers a large area, which consists of two detached districts, practically North Kensington and West Brompton. The generating station is situated off the Richmond-road, West Brompton, and contains space for a very large plant.

The Lowrie-Hall alternating current transformer system is adopted, with 2,000 volts on the mains. Four principal mains at present carry the current from the station, the transformers being connected to these mains where required. Cast-iron pipes are laid to form a conduit into which vulcanised india-rubber "Silvertown" cables are drawn; suitable manholes, covers, and junction-boxes being provided.

At present the demand for light is supplied from a plant consisting of:—

Three "Babcock and Wilcox" boilers, working at 150 lbs. per square inch,

ELECTRIC LIGHTING COMPANIES IN LONDON.

Name of Company.	Capital (Nominal) £	Number of years in exis- tence.	Stations.	Total Indicated Horse-power Engines.	Number of Lamps equivalent to 32 Watt Lamps now connected.	System.	Length of conduit pipe or single run of main.	Lamps per mile.	Meters.		Districts.
									Number	Type.	
London Electric Supply Corporation, Limited.	1,250,000	5	Devereux Con- verting Stations.	4,500	38,000	Alternate current trans- formers (Ferranti).			136 174 14	Ferranti- Mercury. Ferranti- Wright. Fragar.	Parishes of St. James, St. George, Chelsea, Rother- hithe, Bermondsey, Clerkenwell, St. Mark, Newington, Lambeth (part of), St. Martin (part of), St. Margaret and St. John, Westminster. Greenwich district, St. Olave district, St. Saviour's district. Parishes of St. Martin's- in-the-Fields (part of), Bill 1889, Mid-London Order; the Board of Works of St. Giles' dis- trict, Holborn district, Strand district, 1880; West London Order; parish of St. Marylebone, 1889; Paddington Order, parish of Paddington, 1890.
Metropolitan Electric Supply Company, Ltd.	500,000	2½	Whitehall, Sardinia-street, Rathbone-place, Manchester-square.	600 3,000 4,200 2,000	44,598	Direct current and bat- teries. Alternate current trans- (Westinghouse). (Do. (Parker)).	30 miles.	1,486	25 378	Aron. Westing- house.	Parish of St. Mary Abbot, Kensington (two portions of). Parishes of Westminster, Belgravia, and Mayfair.
House-to-House Elec- tric Supply Company, Limited.	350,000	2	West Brompton.	600	12,898	Transformers (Lowrie- Hall).	8½ miles.	1,517	71 168	Lowrie-Hall Westing- house, Aron.	Central Kensington and Knightsbridge.
Westminster Electric Supply Company, Ltd.	214,765	2	Millbank-street, Dacre-street,* Edgemoor-place,† Davies-street,† Kensington-court, Chapel-place.		7,540	Direct current and bat- teries. " " " " " " Direct current and bat- teries (Crompton).	10½ miles.	2,366	200 90 34	Aron. Hookham. Aubert.	Parish of St. Mary Abbot, Kensington (portion of), Parish of St. Mary Abbot, Kensington (portion of), Parish of St. James.
Kensington & Knights- bridge Electric Sup- ply Company, Ltd.	300,000	4	Draycott-place and three distributing stations.	1,560, and Howell Batteries.	24,850	Direct current and bat- teries (King).‡					
Chelsea Electric Sup- ply Company.	108,000	6	Duke-street.	Batteries E.P.S.	19,500	Direct current.	4½ miles.	5,452	190	Aron.	Parish of St. Pancras. Parish of St. Martin's-in- the-Fields.
Notting-hill Electric Supply Company	100,000	1	High-street.†		23,174	Direct current.					
St. James and Pall- mall Electric Supply Company.	100,000	2½	Stanhope-street.† Strand.	1,960	8,500	Direct current.					
St. Pancras Vestry. The Electricity Supply Corporation, Ltd. (for- merly Messrs. Gatti).				600		Lamps equivalent to 8 c.p. each.		Total	1,573		
				Total	179,060						

* Temporary station.

† Now in progress.

‡ Nearly complete, and another station not yet commenced.

§ As published in the *Engineer*, 24th Oct., 1890.

Three "Fowler" compound horizontal engines, each of 200 indicated horse-power.

Three "Lowrie-Hall" alternators, each of 100 units 2,000 volts.

Three "Elwell-Parker" exciters, each of 3 units.

The engines work at a speed of 88 revolutions per minute, each engine driving 1 alternator by 7 cotton ropes, the exciter for each alternator being driven by cotton ropes from the alternator pulley.

The Lowrie-Hall pressure regulator and recording instruments are also used. Mr. Hall, the company's manager, has kindly given me this information, and states that on their lamp connections, equivalent to 12,898 lamps of 8 candle-power, the maximum lamp supply is equivalent to 5,430 lamps of 8 candle-power—say 42 per cent.

ST. JAMES'S AND PALL-MALL ELECTRIC LIGHTING COMPANY.

This company was formed for the purpose of supplying the whole of the parish of St. James', Westminster, and commenced to supply current under their provisional orders from their station in Mason's-yard, Duke-street, on April 4th, 1889.

The direct current is employed without batteries.

At present the above station supplies the southern half of the district, the total plant consisting of:—

Five "Davy-Paxman" boilers, working at 150 lbs. per square inch.

Two large Berryman feed water heaters.

Ten Willans' compound engines, each of 200 indicated horse-power.

Two Willans' compound engines, each of 80 indicated horse-power.

Twelve dynamos, "Latimer Clark, Muirhead & Co.," and "Siemens," driven direct from the engines.

The whole of this plant is neatly arranged, so as to occupy the least space.

The mains consist of a network of conductors on the three-wire system, supplied at about 100 volts at the station by suitable feeders. A cast-iron trough or culvert is laid under the surface of the pavement, and three conductors, each consisting of a number of strips of bare copper, which can be added to at any time, are carried by porcelain bridges, placed at suitable intervals apart. To avoid any risk of the mains touching each other, porcelain distance-pieces are placed over the mains. A cast-iron lid, with water-tight joint, covers the

trough. Connection to customers' houses is made by drawing well-insulated cable through gas tubing, which is screwed into the trough.

On the 5th December, a total, equivalent to 23,174 lamps of 8 candle-power, were connected. Mr. Dobson, the company's engineer, kindly informed me that the maximum lamp supply is equal to about 13,222 lamps of 8 candle-power—say 57 per cent.

THE WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

The district in which this corporation is authorised to supply electricity by its provisional order, comprises that portion of the united parishes of St. Margaret and St. John, Westminster, which lies to the south of the centre line of the Metropolitan District Railway, and the portion of the parish of St. George, Hanover-square, covering Belgravia and Mayfair.

The system adopted is similar to that of the Kensington and Knightsbridge Company, direct current in conjunction with batteries used as regulators, and also for supply during hours of minimum demand.

Three stations are being erected, one at Millbank-street, one at Eccleston-place, and one in Davies-street, in the positions shown on the map.

Current is now being supplied from the Millbank-street station and from a small temporary station in Dacre-street. The other two are being pushed forward as fast as possible, in order to supply from all stations early in the year.

Mains are being laid for a three-wire distribution, Messrs. Crompton being the contractors for the Westminster district, where the system adopted is similar to that put down by Mr. Crompton for the Kensington and Knightsbridge Company.

For other parts of the district Prof. Kennedy, the engineer to the company, has devised the arrangement shown in the plan on the wall; bare copper strip rests on stoneware insulators placed from six to eight feet apart, and bedded in the concrete culvert as shown. The copper is stretched by a special tool before being pulled in, and this process gives it sufficient stiffness not to sag perceptibly between the insulators. The total sectional area of the conductors can be increased when required by the addition of more copper strip. Feeders are used in a most systematic manner, and Professor Kennedy is to be congratulated on the favourable prospects of this company's work. There is

a large demand for light in the district, and the rapid progress of this company justifies the expectation of a speedy supply from the stations now in progress.

THE LONDON ELECTRIC SUPPLY CORPORATION, LIMITED.

The Parliamentary powers possessed by this company cover a large area, comprising the district bordering the south side of the Thames from Westminster-bridge to Greenwich, May-fair, Belgravia, St. James and Pall-mall, St. Martin's-in-the-Fields, part of Westminster, Chelsea, and two isolated areas, namely, Newington and Clerkenwell.

The Ferranti system is employed throughout, alternating current being generated at an extra high pressure and transmitted to converting stations, from which it is distributed at high pressure to the service converters.

The corporation has erected a large station at Deptford, which has been admirably designed for the purpose, having road-frontage, wharfage, and coaling dock. The plant consists of 24 "Babcock & Wilcox" boilers, four compound vertical engines by Hick & Hargreaves, two of which are 1,500 indicated horse-power each, and two of 750 indicated horse-power each. There is almost unlimited room for future extension.

Each of these engines drives a Ferranti dynamo by cotton ropes, the excitors being driven direct from independent engines.

In order to convey the high pressure from Deptford to London, Mr. Ferranti devised a special form of main for this purpose, which has been frequently described.

About 28 miles of these mains have been laid, the distributing mains from the converting stations being of various kinds. This company's Grosvenor Gallery station having lately been closed, a hurried change has had to be made in order to enable the corporation to supply from Deptford.

CHELSEA ELECTRICITY SUPPLY COMPANY.

This company's provisional order covers the whole parish of Chelsea, a portion of which the company is now supplying.

Direct current is employed with accumulators, but, unlike the other companies in London, in this case the accumulators are charged with a high pressure current, and discharge direct at low pressure into the mains. I am not in possession of any information of this company's progress. From published descriptions you will doubtless be aware that the

generating station is situated at Draycot-place, with battery stations at Clabon-mews, Egerton-mews, and Pavilion-road.

THE ELECTRICITY SUPPLY CORPORATION.

This company obtained a provisional order in 1889 for supplying the whole of the parish of St. Martin's-in-the-Fields. Direct current, without batteries. The station is placed just off the Strand, and was laid down, some years ago, by Messrs. Gatti, to supply the Adelaide Gallery and the Adelphi Theatre; it is now being extended. At present the plant consists of:—

Four "Babcock and Wilcox" boilers.

Five Willans' engines, amounting to 600 indicated horse-power.

Five "Edison-Hopkinson" dynamos, each being driven direct from one engine. Callender mains are laid down in Callender-Webber casing.

ST. PANCRAS VESTRY.

The Vestry have decided to carry out the electric lighting of the parish themselves, and have secured the able services of Professor Robinson as their engineer. The direct current system will be adopted, and a station is now being erected in Stanhope-street, Euston-road, for the supply of the south-west portion of the parish.

NOTTING-HILL ELECTRIC LIGHTING COMPANY.

The provisional order granted to this company includes the district of Notting-hill, which comes within part of the parish of Kensington, St. Mary Abbot.

The system is similar to that adopted by the Kensington and Knightsbridge Company.

The first generating station, situated off High-street, Kensington, is now approaching completion, the plant consisting of Babcock and Wilcox boilers, Willans' engines, Crompton dynamos, and Howell batteries; Crompton's mains are also laid as shown in the map on the wall.

THE METROPOLITAN ELECTRIC SUPPLY COMPANY.

The Parliamentary powers of this company include the large and important districts of Paddington and Marylebone parishes, with part of St. Martin's-in-the-Fields, the Holborn and Strand district, and St. Giles' Board of Works.

Various systems are employed by this com-

pany, both the alternating and direct current systems being adopted.

The company is at present supplying from four stations, and it may perhaps be better to describe them separately.

The Whitehall station, situated in Whitehall-avenue, is a direct current station which possesses no novelty, and supplies the surrounding locality, the plant consisting of Hick Hargreaves' boilers, Willans' engines, and Siemens' dynamos. Callender mains are laid down the Northumberland-avenue subway and elsewhere.

The Sardinia-street station contains a complete plant on the Westinghouse alternating current system, consisting of twelve Babcock and Wilcox boilers, working at 150 lbs. per square inch; twelve Westinghouse alternators, each being belt-driven by a Westinghouse compound engine, as shown on the plan. There are also three exciters, each being belt-driven by its own engine.

The Manchester-square station contains nine Babcock and Wilcox boilers, ten Parker alternators, each driven direct by a 200 horse-power Willans engine, as shown in the sketch of the engine-house placed on the wall. There are also four exciters, each being driven direct by a Willans engine. The steam piping is arranged on a method devised by Mr. J. H. Rosenthal, the London manager of the Babcock and Wilcox Boiler Company, and possesses many advantages.

The Rathbone-place station contains plant of a similar kind, there being five boilers, six alternators and engines, two exciters and engines.

The system of distribution from the three latter alternating current stations is of a simple description—cast-iron pipes laid underground form conduits, into which "Silvertown" vulcanised rubber cables have been drawn when required. Split T-pieces are inserted in the pipes for connection to customers' premises. These mains are looped from house to house, returning to the station, so as to form complete rings. Each customer has, therefore, a duplicate supply, thus enabling new customers to be connected to the system without interrupting the supply on the circuit.

All these three stations are connected together by trunk mains, which enable one station to assist another, or take the whole load of the district during the hours of least demand. The current leaves each of these stations at a pressure of 1,000 volts, this

moderate pressure being adopted as the number of supply stations reduces the distance to which each cable has to be laid to meet the demand. The whole supply is distributed by a number of small cables, which can be easily replaced when required.

The demand for light has been very encouraging; and, as you will see from the Table, the progress of the lamp connection to these stations has been very rapid. I regret, however, to say that, although this company at present supplies light to twelve public-houses, only four churches are, so far, connected with the system.

Having now completed our tour of the stations of the various companies, we have seen how the streets of London have lately been disturbed in order to lay all these mains; no doubt a certain amount of inconvenience has unavoidably been caused to traffic, but it has revealed the wonderful system of organization by which London is governed; and the vestry surveyors, whose labours have been much increased, have not only afforded every facility for carrying out the work, but have rapidly re-instated the pavements at, of course, the cost of the respective electric light companies. The public, therefore, though for a short time inconvenienced, have in reality secured new pavements for old.

Summarising the plants adopted by the various supply companies, it is interesting to notice how the peculiar conditions of electrical supply in the very limited space usually available have been provided for by manufacturers. As an instance of this, it may be noted that "Willans" engines, amounting to about 9,000 horse-power, are used by the public supply companies in London, and similar engines, aggregating more than 2,000 indicated horse-power, for private plants in the metropolis. The Babcock and Wilcox boiler having also been so universally adopted, it may be of interest to state that 78 boilers of this type, supplying 14,230 indicated horse-power, are now at work in London.]

PRIVATE PLANTS.

One result of the Act of 1882 has undoubtedly been to cause a large number of private installations to be erected, but so many of our leading electric light contractors have laid down thoroughly efficient plants that there is perhaps no cause for regret. Most of the large terminal London railway stations work their own electric light machinery, the largest installation being at Paddington, where the

Great Western Railway Company have machinery of 1,500 horse-power for this purpose. For residences, gas-engines provide the motive power for driving dynamos supplying about 18,000 lamps of 32 watts each, the remainder being steam-driven.

It may be of interest to note that the Crossley "Otto" gas-engine, which was awarded a gold medal at this Society's recent motor competition, is being employed for this purpose, amongst others, by Messrs. Laing, Wharton and Downe. This total may appear large, but it must be remembered that many of the large hotels having their own steam plant for working lifts, warming and cooking, have added electric lighting machinery; the total also includes the lamps at D'Oyly Carte's new theatre, where Messrs. Verity have erected a plant so complete that it may almost be considered as a small central station.

NUMBER OF INCANDESCENT LAMPS NOW IN USE IN LONDON.

With the kind assistance of the electric light contractors, particularly Messrs. Verity, Laing, Wharton and Downe, Phipps and Dawson, Drake and Gorham, Sharp and Kent, and many others, and the public supply companies, I have been able to collect data that the total equivalent number of 32 watt lamps now in use in London is approximately as follows:—

Public Supply Companies	179,060
Private Plants	85,000
Total.....	264,060

At the present rate of increase a very moderate estimate gives an addition of at least

4,000 lamps per week, and there is little doubt that this number will be greatly exceeded at no distant date.

All these incandescent lamps have been calculated on a basis of 32 watts or 8 candle-power lamps, as experience has shown that this is a size much used in London, and, by taking the smallest lamp, we avoid dealing with half lamps.

Before leaving these particulars, it will probably be of service to the designers of future stations if we tabulate the data collected.

TABLE SHOWING PER-CENTAGE OF MAXIMUM LAMP SUPPLY AT ANY MOMENT TO TOTAL LAMP CONNECTION.

Station.	Per-centage.
House-to-House	42
Kensington and Knightsbridge.....	30 to 40
St. James' and Pall-mall.....	57
Sardinia-street	45
Rathbone-place	64
Manchester-square	45

It perhaps may be of interest if I draw your attention to the following Table, based upon data which has come under my observation, showing the candle-power of lamps mostly used:—

LAMPS(50 VOLTS).						
8 c.p.	16 c.p.	32 c.p.	50 c.p.	100 c.p.	200 c.p.	500 c.p.
597	1,666	62	13	8	8	3
LAMPS (100 VOLTS).						
5,437	5,131	176	26	57	40	3

During 1886 and part of 1887 I was able to collect the following data of the behaviour of incandescent lamps, each of 25 candle-power, with an efficiency of $3\frac{1}{2}$ watts per candle, and, I trust that more information of this kind will be collected:—

INCANDESCENT LAMPS.—LIFE, AND NATURE OF FRACTURE.

All Lamps 25 c.p. Brass Collar, Edison-Swan.

LAMPS.			NATURE OF FAILURE.											
Volts	No. of lamps re-nued.	Average life. hours.	Glass Globe.						Filament Fractured.					
			Broken.	Per cent.	Blackened	Per cent.	Plaster.	Per cent.	Loop.	Per cent.	Stem.	Per cent.	Joint.	Per cent.
151	536	861	114	21.2	21	3.91	56	10.44	208	38.80	114	21.26	23	4.29
142	189	789	19	10.0	4	2.11	41	21.69	67	35.45	47	24.96	11	5.82
120	2,549	923	273	10.7	92	3.60	334	13.1	1,114	43.70	693	27.10	43	1.68
99	588	1,423	122	20.7	61	10.37	92	15.64	212	36.00	95	16.10	6	1.02
	3,862		528		178		523		1,601		949		83	
				13.67		4.61		13.54		41.46		24.57		2.15

With reference to arc lighting, considerable progress is being made; and, although the number now in use in London does not much exceed 1,000 lamps, there is no doubt that rapid progress will be made.

Professor Sylvanus Thompson, in March, 1889, showed you all the best known arc lamps; and, for further information of their development, I must refer you to his most complete paper on this subject, published in the Society's *Journal*, March 8th, 1889.

It is a matter for regret that there is no progress to be noticed in connection with the efficiency of the incandescent lamp, which remains much the same as it was five years ago. It will be apparent from the Table showing the candle-power of lamps mostly used, that a really efficient 100 volt 8 candle-power lamp is much needed; the present lamps of this kind have such a short life that customers, contractors, and electric supply companies would all hail its advent as a boon.

We must also remember that the future progress of electric lighting depends in no small measure on the lampmakers, and as the manufacture of the incandescent lamp will soon be open to all (owing to the expiration of the present patents) the absolute necessity of a standardizing laboratory must compel its adoption where not only instruments but lamps can be tested, so that people may know when they ask for an 8 candle-power 100 volt lamp, with or without a guaranteed life of say 1,000 hours, at an efficiency of $3\frac{1}{2}$ watts per candle, that they get what they have asked for.

That this question of lamp efficiency is of importance to customers and supply companies alike few will doubt, and the following Table will probably explain itself:—

Watts per candle.	Candles per 1,000 watts.	Lamps per 1000 watts.			
		8 c.p.	16 c.p.	20 c.p.	32 c.p.
2'00	500'0	62'5	31'2	25'0	15'6
2'25	444'5	55'5	27'7	22'2	13'9
2'50	400'0	50'0	25'0	20'0	12'5
2'75	363'6	45'4	22'7	18'2	11'4
3'00	333'3	41'7	20'8	16'7	10'4
3'25	307'6	38'4	19'2	15'4	9'6
3'50	285'7	35'7	17'8	14'3	8'9
3'75	266'6	33'3	16'7	13'3	8'3
4'00	250'0	31'2	15'6	12'5	7'8

We see then how an improved lamp efficiency will benefit the supply companies, by enabling them to increase their lamp connection.

The following Table will appeal most strongly to all users of the incandescent lamp; but it must be assumed that an increased efficiency is not obtained at the expense of a reduced life of the lamps.

The most satisfactory feature, however, of the present Edison-Swan lamps is the uniformity of their voltage; and the scientific department of the Edison and Swan Company's works is to be congratulated on the assistance they have given to the industry, by practically enabling voltmeters to be set by photometrical tests of the lamps.

COST PER ANNUM PER 8 CANDLE-POWER LAMP AT 8D. PER UNIT, LAMPS BURNING AN AVERAGE OF :—

Per day.	$\frac{1}{2}$ hour per day.	1 hour per day.	2 hours per day.	3 hours per day.	4 hours per day.
Hours per Annum.	182 5.	365	730	1,095	1,460

Cost per annum with lamp efficiency of:—

2 watts per candle.	£ s d.	£ s d.	£ s d.	£ s d.	£ s d.
2'25	0 1 11	0 3 11	0 7 10	0 11 9	0 15 8
2'50	0 2 2	0 4 5	0 8 9	0 13 2	0 17 6
2'75	0 2 5	0 4 10	0 9 9	0 14 7	0 19 6
3'00	0 2 8	0 5 4	0 10 9	0 16 1	1 1 5
3'25	0 2 11	0 5 10	0 11 8	0 17 6	1 3 4
3'50	0 3 2	0 6 4	0 12 8	0 19 0	1 5 4
3'75	0 3 5	0 6 10	0 13 8	1 0 5	1 7 3
4'00	0 3 8	0 7 4	0 14 7	1 1 11	1 9 2
4'00	0 3 11	0 7 10	0 15 8	1 3 6	1 11 4

It may be thought that an estimated use of a lamp for only about 200 or 300 hours per annum is very low, but it should be remembered that the electric light need only be used when it is required, as the ease of switching it on and off makes us forget all our past troubles in hunting for gas-taps, matches, and broken gas-globes. With ordinary care, the average cost of burning an 8 candle-power lamp for ordinary domestic use need not exceed ten shillings per annum.

Of course much depends on the wiring contractor, who not only has to be an accomplished art critic in designing or selecting the brackets, pendants, &c., but he has also to suggest the most advantageous positions for the lamps and switches. A switch placed near the door

of every room, and not less than two lamps in any room, will probably save annoyance.

The greatest progress has been made in the wiring of houses; not only is more work done, but it is better done and on more mechanical principles, for whereas some years ago a single main would have been run from top to bottom of a house with numerous T-joints, independent circuits will now be wired, and all brought to a neat form of distributing board.

The effect of the extra care which is now taken with this work is proved by the following table of insulation tests, taken with 100 volts at 200 houses:—

INSULATION TESTS OF INTERNAL WIRING
(TAKEN WITH 100 VOLTS—EVERSHED
OHMMETER.)

Number of Points.		Test Megohms.
5 to 10	Average of 15 houses	4.0
10 „ 15	„ 23 „	3.5
15 „ 20	„ 18 „	2.8
20 „ 25	„ 13 „	2.7
25 „ 35	„ 33 „	1.8
35 „ 40	„ 12 „	1.5
40 „ 50	„ 16 „	1.2
50 „ 60	„ 12 „	1.1
60 „ 70	„ 9 „	1.0
70 „ 120	„ 14 „	.4
120 „ 220	„ 9 „	.25

I hoped to have been able to place before you some record of the improvement in the health of London owing to the progress of electric lighting, but so much has already been said and published about it that further facts appear needless. It is simply melancholy to see so many of our churches and halls not only burning their gas-jets for lighting, but also for “warming” the building. If culpable negligence amounts to manslaughter, the people responsible for this atrocity ought to receive their deserts.

Having now placed before you some account of the progress of electric lighting in London, I must ask you to compare our metropolis with other cities, and leave you to judge whether we are so very far behind them as some would have us believe. Is it not more probable that other countries will be glad to avail themselves of the experience which London must gain in the working of so many distinct systems?

DISCUSSION.

The CHAIRMAN said Mr. Bailey had been good enough to attribute to him a share in the Act of 1888, which he must disclaim. He took an active part in preparing a Bill which was not passed, and the one which did become law, for which they had mainly to thank Lord Thurlow and his colleagues, was one which he regretted was accepted, because it left in full force what he considered the vicious principle of Government trading, though it extended the previous impossible term of 21 years to 42, a term which he had hoped would also have been treated as impossible. Under the Act of 1882, public electric lighting in England was impossible, and progress was greatly retarded in consequence. Some astonishment had been expressed at the large number of private installations as compared with public ones—practically halving the number of lamps—but that was entirely due to that Act. People wanted the electric light, and as the Legislature prevented it from being supplied in the ordinary way in which such illuminants as gas was supplied, those who had the requisite means and space at command did it themselves. As he had said before, electric lighting owed much to Sir Henry Trueman Wood, who as long ago as 1882 started the electric light in the Society's meeting-room and throughout the house, and it had been as successful there as anywhere in London. Mr. Bailey seemed to be of opinion that the use of the Crossley gas-engine for electric lighting was due to its success at the trial of motors there; but one had been at work in the cellars of that house since 1882, and was still at work, and, according to his experience, a great many other private institutions used the same motive power.

Mr. R. E. CROMPTON said electric engineers might feel proud that, although they had been so heavily handicapped in the race, they had begun at last to bring London to the front, and it would not be long before they were as far ahead of any other town in the world in electric lighting as they were in most other respects. The Act of 1882 completely stopped electric lighting for several years, though, as engineer to the Edison and Swan Company, he then designed several central stations which, even in the light of present knowledge, he could say could have been carried out practically as well then as they could now. The one at Victoria Station, and another in the Strand district, were, in many respects, as well designed as those he had since been connected with. The chairman of the company at that time, however, thought—probably rightly—that it was not fair to put the shareholders' money at the mercy of the provisions of that Act, under which the undertaking could be purchased at breaking-up price at the end of such a short period, and the scheme was therefore never carried farther than the lighting of Victoria Station, though it could have been worked, within a small per-centage, as economically and as well as many which had been

tarted recently. In that station, the dynamos were in the upper floor. Five years ago, a gentleman called at his office and said he was connected with an estate company which had a subway, so that underground mains could be laid without coming under the Act, and the result was the formation of the Kensington court Company, his informant being Mr. Granville Ryder, the present chairman of the company. At that time not a single underground main had been tried, and but for his opportunity of testing the system, it was very improbable that either the Kensington-court Company, the Whitehall, or the Metropolitan Company would have occupied the positions they now did. The results then obtained led to the agitation which produced the amended Act. The public should know that though they might have been inconvenienced by the breaking up of the streets, it was a very different thing from similar annoyances on the part of gas and water companies, because in most cases the work was done once for all. Conduits or pipes had been laid, into which the conductors could be drawn, and from which they could be withdrawn and repaired, so that connections could be made without further breaking up of the road. He did not know the exact mileage, but he should think nearly 150 miles had already been laid, which was no small feat to accomplish since the provisional orders were obtained two years ago. In the system of underground conductors with which Mr. Bailey had connected his name—though it was by no means the sole inventor, many other engineers having contributed to its development—the idea was not only to give access to every house for the electric light, but to afford sufficient means of access for many other systems of conductors in the future—telephone wires, fire alarms, and other means of communication, which would be greatly appreciated in future, and though the idea might now seem Utopian, he hoped the time would come when compressed air might also be supplied for the purpose of giving cool storage in every larder.

Professor KENNEDY, F.R.S., said this paper would be much quoted after a few years, for Mr. Bailey had given a most vivid picture of the state of electric lighting in London, just at the time when it was most interesting. As to the maximum number of lights at one time in use as compared to the total number on the station, he had been apparently very fortunate in one of his own districts. He had found in Westminster the usual average was about 40 to 42 per cent., but one foggy day in last week it went up to 60 or 61, judging from the amount of current going out. As to the state of electric lighting in London compared with other places, there was no other city in the world that had 250,000 lights, or anything like it. He believed it was about double the amount in use in New York, and before long people would be coming here for information, instead of scoffing at us for doing nothing. With regard to safety working a station, he thought that there should

always be power in reserve equal to one of the largest units; if 200 horse-power engines were the largest used, for instance, there should be 200 horse-power in reserve, but the use of one 500 horse-power engine necessitated at least 500 horse-power in reserve, and so on. He should be glad to think that putting a boiler on a lower level than the engine would ensure having dry steam, but rather doubted whether that was proved experimentally. If the particular boilers mentioned gave dry steam, he did not think it could be owing to their position in reference to the engine.

Professor FORBES, F.R.S., asked what the black spider-like lines on the map indicated? Mr. Bailey had collected an enormous number of the very facts engineers wanted to arrive at, and he hoped other gentlemen connected with central stations would follow his example and give the result of their experience. Mr. Bailey seemed rather hurt because various people had criticised the progress of electric lighting in this country, and contrasted it unfavourably with what was done elsewhere, and perhaps few had done more in that way than he (Prof. Forbes) had. He had taken the pains to learn what was being done in foreign countries by personal inspection, and had frequently, on his return from such enquiries, done his best to impress on those concerned at home the superiority of the work which was being done abroad. The last time he had occasion to do so was about three years ago, when hardly any of the work now described had been commenced; but he now thoroughly endorsed what had been said by Professor Kennedy, that there was not an example in the whole world of such enormous progress in so short a time. They were delayed for a long time by the former Act, but during all that time they were studying what was done elsewhere, so that when they began they were on sure ground, and went ahead with more confidence than people elsewhere had done. Not only was the scale of work greater in London than anywhere else, but the character of the work in the central stations would bear comparison with any. Any one who had visited the Sardinia-street station would feel that it was as complete and satisfactory as it could possibly be.

Mr. W. M. MORDEY said that he believed this paper would be of the greatest value. He suggested that it should be followed, at fairly frequent intervals, with other accounts of the work that was actually being done. He remarked that Mr. Bailey's particular arrangement of primary mains, which was very simple and ingenious, had not been alluded to in the paper. It would be very useful if they could have not only the relative life of 50 and 100 volt lamps but their relative efficiency. It would be well to know how much the lowering of the candle-power of the former counterbalanced the advantage of the longer life, the blackening of the globe in a low voltage lamp being always more serious than in the case of a high one. A

strong confirmation of what had fallen from the Chairman and Mr. Crompton as to the effect of the Act of 1882 was to be found in experience abroad. It was often stated that our knowledge of how to distribute electricity had greatly advanced since 1882. This was true, but it was also true that, so far as supplying lights in a densely inhabited district was concerned, no great advance had been made or was to be expected. As an illustration of this, he referred to Milan, where a large scheme had been carried out on the lines that were available in 1882. Just about 1883, a station was put down there which had never had the current off the mains for six years, and it was now supplying 25,000 16 candle-power lamps, on the direct low-tension system. The history of that station showed that, in a dense area, the old-fashioned system was very good in its way, even without the advantage of the three-wire arrangement. Distant places—suburbs, and so on—could not be supplied, but they were now supplying the more distant parts on the high-tension system, somewhat similar to that mainly used by Mr. Bailey's company. The history of the Metropolitan Company illustrated the advance in knowledge of how to distribute light over a large area economically, especially in the early stages of the work. That company started with a low-tension system and with batteries; but all the stations added since were on the high-tension system, without batteries. They knew now how to supply both in dense areas and over long distances. Mr. Crompton had, in London, perhaps done more than any one in the former direction, and the Metropolitan Company more than any one—except perhaps Mr. Ferranti—in the latter. A great deal had been said by Mr. Preece and others in that room on the advantage of lighting streets by arc lamps. It appeared that there were only about 1,000 in use in London altogether. He thought the general public would never fully appreciate the advantages of electric lighting until the whole of the main streets were illuminated in that way. Nothing had been said about the electric lighting of the City, no doubt for the reason that there was at present no lighting in the City. This reproach would shortly be removed, his company and others having undertaken a general lighting scheme, which, he was glad to say, included street lighting by arc lamps.

Mr. R. W. WALLACE pointed out the great importance of endeavouring to improve incandescent lamps. He believed, from some experiments which had been made, that it would be possible to reduce the amount of current used in these lamps by about one-third, though the result might be to shorten the life of the lamp. But when one considered the value of the lamp compared with the price of the current for a number of hours, that would be but a small matter. He hoped, therefore, that inventors would turn their attention in this direction.

Mr. CHAPLIN said it would be very interesting to know if there were any data showing whether an in-

candescent lamp worked with a low-tension current had a much longer life than one worked with a high-tension.

Mr. BAILEY, in reply, said that so far as he could ascertain there were now $81\frac{1}{2}$ miles of conduits of all kinds, in some cases pipes, in others concrete or brickwork; and into these conduits were led about $111\frac{1}{2}$ miles of cable, which were actually carrying current at the present moment; and that had practically been accomplished in eighteen months, in order to supply the public with electric lighting, but they had not yet got to street lighting. That brought him to the question of arc lamps. Everyone would like to see arc lighting, but they could never expect to see it in London in such perfection as in Milan and other places where the streets were practically built for it. One could not imagine the Strand looking particularly handsome, even with the aid of arc lamps; it was quite different in Berlin, where they could be placed in the centre of the roadway on very high masts; but such as the streets of London were, they would be immensely improved by arc lighting, and he believed this would come shortly; and in place of the very meagre account of this system which he had been able to give, he hoped before long to hear someone else give a much more ample description of what was being done in this way. Everything was now ready for it, and he could not quite understand what kept it back. Professor Kennedy had referred to the maximum per-centage of supply to the total lamp connection, as to which you might take either the average or the heaviest day, the figures given in the paper being the heaviest lighting day in November; and he found that in all the districts from which he had collected information that the heaviest duty came on between four and five in the afternoon. (He exhibited a number of diagrams showing the varying amounts of current demanded during the day, plotted on a curve, taken at different stations and on different days, the highest point varying according as the district consisted mainly of offices, shops, or theatres and restaurants.) The black spider-like lines which Professor Forbes referred to, showed overhead wires, and he desired to emphasize what he had said in the paper on this point. There were over 25 mile of these overhead lines, and he could not remember a single accident attributable to them. The prejudice which existed against them was due to the wretched work done in New York, where they neither suspended the wires nor properly insulated them, but left them to rot, and then people said how dangerous they were. Mr. Mordey had kindly alluded to the arrangement of mains which he was endeavouring to carry out, and which he (Mr. Bailey) did not allude to in the paper because he did not want to advertise himself. There was no particular novelty about it; they were merely acting on mechanical principles, and endeavouring to give people a double supply, one from each end of the cable, so that when a

new customer wanted to come on, there was no need to go round to all the subscribers and tell them they must be shut off. With reference to the incandescent lamps, he hoped others would keep a record of the behaviour of all the lamps under their charge, which could easily be done. He had an india-rubber stamp, with a movable date, which was stamped on the cement when the lamp was sent out; when it failed, and was brought in to be replaced, the storekeeper could tabulate the date and the fracture in the filament, and these records would be very valuable. In a few years' time it would be open to anyone to make lamps; and people then would buy from those who produced the cheapest and most durable. Mr. Mordey had referred to the Whitehall Company and the alteration they had introduced in the other districts as the system developed. That was due to the size of the districts which that company had to light; it was not only a question of providing light, but of doing it quickly, for nowadays, as soon as anyone had his place wired, he wanted the current the next day; and if he did not get it, he worried the life out of the unfortunate engineer to the supply company. He hoped, before long, someone would read a paper showing the benefit to the health of the people conferred by electric lighting, the decrease in headaches and in doctors' bills. The other day, a certain firm took proceedings against an electric light company for not continuing the supply, and stated on oath that whereas with the electric light they could go for six years without decorating their premises, when using gas they had to paint and whitewash every two years, and they claimed damages in consequence. He hoped the Vestries would soon see the advisability of lighting the streets by arc lamps.

The CHAIRMAN, in proposing a vote of thanks to Mr. Bailey, said he prophesied two years ago that in ten years time 90 per cent. of all the houses at the West-end of London, of £400 a year rental and upwards, would be lit by electricity. He now began to think that he had not been sufficiently sanguine, and that he might have mentioned a rental of £300 instead of £400. So long as gas was supplied at 2s. 9d. or 2s. 6d. per 1,000 feet, the electric light, until improved in some way—and the only improvement that seemed possible was economy in the lamp—must be a light of luxury; but persons who would pay £300 or £400 a year rent were willing to pay £20, £30, or even £40 more for electric lighting, as compared, not with gas, because many would not use it, but with the other illuminants they employed. After a year's experience of the use of a number of lamps equal to about 114 8-candle lamps, he found the extra cost was between £20 and £25, as compared with the gas, candles, and lamps he used before, and in that he made no allowance for decreased expenditure in cleaning, painting, and matters of that kind,

which was undoubtedly considerable. He had also a curious experience, during the summer quarter, of the truth of what Mr. Bailey said about the ease with which the electric light was extinguished and re-lighted. His summer quarter's bill for electric lighting was only a few shillings in excess of the gas bill for the previous year's summer quarter, and he bought no candles or lamp oil, having the electric light all over the house. The reason was simply this, that in a dark London basement, even in the summer-time, the gas was kept constantly burning, but the electric light was turned out when not wanted, and though no doubt it was considerably dearer than gas, so much less of it was used, even by the servants, that it only cost a few shillings more.

The vote of thanks was carried unanimously, and the proceedings terminated.

Messrs. Osler and Messrs. Verity exhibited table lamps and other fittings at the meeting.

Correspondence.

CHICAGO EXHIBITION OF 1893.

On considering Mr. Dredge's admirable paper on the forthcoming Chicago Exhibition, I have thought that it would be well to consider the question of awards to British manufacturers who may exhibit. Sir Henry Trueman Wood touched on the question in his paper on the Paris Exhibition read before the Society some time ago, and from my own observation at the principal exhibitions of the last few years I have felt that many awards are far from satisfactory; also that many firms whose manufactures are known to be of the highest order are occasionally deterred from entering exhibits on account of the difficulty of judging their productions by the observation of those who are not always able to recognise the merits of the goods they are called upon to judge. In the Paris Exhibition I saw an exhibit of a single polished roller for flatting mills for metals, which, if I recollect rightly, received an award. I consider it utterly impossible to give an opinion as to excellence in a case of this kind by observation only. Flatting rollers can only be tested in pairs, and then only in actual work, as so much depends on the absolute truth of each roller and their perfect coincidence with each other. Then, again, the temper must be correct, or they will not stand the strain if too hard, or will bruise if too soft. This is only one of the many instances that came under my notice, and it appears to me that awards in machinery and metal work generally depends largely on the polish or the amount of gilding and nickel plating introduced, especially in the case of lathes or other light

machinery used mostly by amateurs. Materials used in manufactures, such as varnishes, alloys of metals, rubber, &c., are also difficult to test except by long usage. The day has passed for manufacturers of articles of importance to attach any value to exhibition awards, and they prefer to rely on the intelligence of those persons who are practically connected with their especial productions, and through them to increase the commercial value of the goods they exhibit. I beg to suggest that the British manufacturers combine to decline awards, and show the world their wares, and rely on the judgment of the vast assemblage of visitors from all countries, and of all trades and professions, to decide for themselves.

F. W. FLETCHER.

December 4th, 1890.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

DECEMBER 17.—GEORGE DAVISON, "Impressionism in Photography." PHIL. R. MORRIS, A.R.A., will preside.

CANTOR LECTURES.

The following Courses of Cantor Lectures will be delivered on Monday evenings at Eight o'clock:—

Prof. VIVIAN B. LEWES, "Gaseous Illuminants." Five lectures.

LECTURE IV.—DECEMBER 15.—The enrichment of coal gas by highly carburetted water gas—The Springer, Lowe, Meeze, Flannery, Stapp, Locmis, and Van Steenberg processes.—Studies in carburetted water gas.

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

January 26; February 2, 9.

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

February 16, 23; March 2.

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

March 9, 16, 23.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

JUVENILE LECTURES.

Two Lectures, suitable for a juvenile audience, will be delivered by E. B. POULTON,

M.A., on "Mimicry in Animals," on Wednesday evenings, December 31, 1890, and January 7, 1891, at Seven o'clock.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 15. SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "Gaseous Illuminants." (Lecture IV.)

North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.45. 1. Mr. W. Hük, "The Unsinkability of Cargo Steamers."

2. Mr. Sandeson, "Main Steam Pipes."

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m.

Mr. A. Mitchell, "English Architecture of the Middle Ages."

TUESDAY, DEC. 16 ... Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on the following papers:—1. Mr. F. E. Robertson, "The Lansdowne Bridge over the Indus at Sukkur" 2. Mr. E. W. Stoney, "The New Chittravati Bridge, Madras Railway."

Statistical School of Mines, Jermyn-street, S.W., 7¾ p.m. Sir Charles W. Dilke, "Statistics of the Defence Expenditure of the chief Military and Naval Powers."

Pathological, 20, Hanover-square, W. 8½ p.m.

WEDNESDAY, DEC. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. George Davison, "Impressionism in Photography."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Robert H. Scott, "Note on a Lightning Stroke presenting some features of interest." 2. Mr. Arthur Brewin, "Note on the effect of Lightning on a Dwelling-house." 3. Capt. M. W. C. Hepworth, "Wind Systems and Trade Routes between the Cape of Good Hope and Australia." 4. Edward Mawley, "Report on the Phenological Observations for 1890." 5. Mr. W. Doberck, "The Climate of Hong Kong."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7¼ p.m. 1. Discussion on Mr. Hardingham's paper "Working German Patents." 2. Mr. G. B. Ellis, "The Doctrine of Equivalents, Mechanical and Chemical."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, DEC. 18...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. R. J. Harvey Gibson, "The Structure and Development of the Cystocarpus in *Catenella opuntia*."

2. Mr. G. F. Scott Elliot, "The Effect of Exposure on the Relative Length and Breadth of Leaves."

Chemical, Burlington-house, 8 p.m. 1. Dr. N. Collie, "The Constitution of de Hydraulic Acid."

2. Mr. S. U. Pickering, "The Theory of Dissociation into Ions and its Consequences." 3. Dr. A. Colefax, "Phennoic Acid."

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. R. S. Poole, "Alexander and his Successors; their Influence on Art and Manners."

Historical, 20, Hanover-square, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, DEC. 19...Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Journal of the Society of Arts.

No. 1,987. Vol. XXXIX.

FRIDAY, DECEMBER 19, 1890.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, December 31st and January 7th, by E. B. POULTON, M.A., on "Mimicry in Animals."

The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. Tickets are now in course of distribution, and members requiring them should apply at once.

CANTOR LECTURES.

Professor VIVIAN B. LEWES delivered the third lecture of his course on "Gaseous Illuminants," on Monday evening, 15th inst.

The first lecture will be printed in the next number of the *Journal*.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, December 17th, 1890: B. FRANCIS COBB, Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Blades, Rowland Hill, 23, Abchurch-lane, E.C.
 Blissett, T., 5, Grenville-ter., Cromwell-rd., S.W.
 Erhardt, William, 7, Bury-street, Bloomsbury, W.C.
 Fearson, Henry S., 5 & 6, Great Winchester-st., E.C.
 Firth, John W., Manningham, Bradford, Yorks.
 Jones, Edward, 5, Moorgate-street, E.C.
 Lane, Frederic, 3, Crown-court, Old Broad-street, E.C.
 Sutton, George, 27, Martin's-lane, Cannon-street, E.C.
 Thorne, Edward Alexander, 1, Blenheim-road, Bedford-park, Chiswick.
 Watts, John Isaac, 4, Halkin-street West, Belgrave-square, S.W., and Whistley-house, near Devizes, Wilts.

The following candidates were balloted for, and duly elected Members of the Society:—

Blundell, Harold, 2, Croftdown-road, Highgate-road, N.W.
 Brenon, Edward Saint John, 6, Gunterstone-road, West Kensington, W., and Savage Club, Adelphi-terrace, W.C.
 Brocklehurst, Henry, Hornesefton, Sefton-park, Liverpool.
 Cox, H. Bertram, 15, Barton-st., Westminster, S.W.
 Dunn, Archibald Joseph, 23, Applegarth-road, West Kensington, W.
 Elms, Charles, 36, Mount Stuart-square, Bute Docks, Cardiff.
 Glegg, Patrick Adam, 5, Moorgate-street, E.C.
 Lyall, George, 48, Winchester-street, South Shields.
 McClure, William Lees, J.P., The Lathams, Prescott.
 Mendelssohn, Hayman Seleg, 10, Pembridge-crescent, Notting-hill-gate, W.
 Murray, James Charles, Holmsted, Bushey-heath, Herts.
 Thorne, William, Burntwood-lodge, Wandsworth-common, S.W.
 Verdin, William Henry, J.P., Darnhall-hall, Winsford, Cheshire.
 Wiseman, E., Cheapside, Luton.

The paper read was—

IMPRESSIONISM IN PHOTOGRAPHY.

BY GEORGE DAVISON.

This is an age of scientific inquiry in every branch of knowledge. Empiricism, irrational

authority, and conventions have been largely cast aside, and freedom of thought and scientific investigation have taken their place. Phenomena are closely observed, and a basis of material fact and proof is demanded for every principle that is sought to be established, whether in biology, mental and moral science, or philology. Matter is held to be the storehouse of every possibility, and the observation of its infinite functions the only source of true and useful knowledge and progress.

The supernatural is losing its power to command worship, and a nobler wonder, roused by the laying bare of the natural causes of the phenomena of the universe, reigns in its stead. Poets and philosophers have, equally with scientific men, been affected by the freer spirit. Literature has more of the true character of life and nature in it, and the newer light has even written its effect in our later students' text-books. Finally, in art the same influence is discovered in the revolt against conventionalism and in the scholarly practice of those painters who have been variously called impressionist, naturalistic, and the like.

It would have been indeed strange if, amongst all these changes of principle and action, which we are pleased to call progress, the domain of art had remained untouched and unaffected. For the painter's art has been trammelled by conventions and chained by dogma equally with ethics and science. There have been unnatural conventions in regard to colour, conventions about form and proportions, conventions concerning light and shade, arrangement of lines, and decorative qualities, as well as many other marks and mannerisms imitated in a manner tending to obscure and lead away from the greatest beauty in pictures—namely, their truth to nature.

It has been well said, "It is so much easier to do what one has done before than to do a new thing, that there is a perpetual tendency to a set mode, but Nature abhors mannerism, and has set her heart on breaking up all styles and tricks." Now these "set modes" and conventional treatments in art have been such that the more they have been compared with natural facts, facts of atmosphere, facts of light, facts of colour, the more have their formality and falsity become apparent to unprejudiced observers influenced by the spirit of free and scholarly inquiry. Nothing but a return to nature can break up such "styles and tricks," and free an artist from the tyranny of previous great names and works.

It was such a return to nature, such a close observation of natural appearances under the influence of the materialistic tendency of the age, that led to the growth and practice of the body of painters known as Impressionists. Abandoning all consideration of the arrangements and mechanism of previous workers, they have consulted only their impressions of natural scenes, and, to those impressions, painted. With one point of sight and one subject of supreme interest they have aimed to seize above all else the action and first impression of that subject. The effect of such work upon the painters of the older conventions, and upon their following amongst the public, was to rouse hot opposition, but the best of the new influences have had very considerable effect upon the more liberal of established painters. De Chesneau, writing of the pictures of M. Monet, says:—"In spite of such works as these the eye of the public—trained to exclusiveness by long intercourse with other and no less legitimate readings of nature, and prevented in a great measure by the abuse of facile tricks of painting—refuses as yet to recognise the purpose and merit of this school. But it will come to it."

A more judicious section, those who seek a natural and scientific basis for their practice, has preferred, as far as such tenets permit any crystallizations, to style itself "The Naturalistic School." The painters of this school, seeing the conventional untruths generally practised in pictorial representations in regard to light, colour, and atmosphere, have set themselves to the practice of close observation of nature to gain a better knowledge of the infinite mysteries of these phenomena. Truth to nature is the first article of their faith, and the truest that science teaches concerning light and colour, and the manner in which the eye sees, is made a guiding principle. Every naturalistic artist must be a scholar. Happily, a cultured sense arrives at the same preference as that to which in the main the scientific inquirer is led. Should any fresh investigation lead to a truer view of physical or mental fact, the naturalistic student, to deserve the name, must readily make a re-adjustment of his principles and modify his methods in accordance. It is not unnatural that the eccentricities, as well as the genuineness of a new development should come to be regarded as distinctive of a school, but it must be remembered that any tenet or practice, to be naturalistic, must stand the test of scientific

investigation. Naturalism, then, instead of signifying indistinctness and eccentricity, as is not uncommonly supposed, purports to be the gospel of common-sense, scientific inquiry, and culture in art. It leaves its advocates free to express themselves about what is going on in the world by means of their graphic art, without other trammels than a severe regard to truth, naturalness, and perfect expression. The naturalistic painters find the possibilities of all poetry in nature; it is truthful representation, perfect expression, that constitute their art. They hold that what is seen should be painted, that symbolism and imaginative creations can have but a feeble interest, and that what we have actual contact with in life affords the opportunity for the most powerful expression by graphic art of any abstract quality. It is in the life of to-day, and not in the illustration of other people's ideas, whether past historical subjects or so-called works of imagination and allegory, that the proper province of the painter's art is to be found. To be true, and living, and moving to our sensibilities, the scenes and subjects depicted must be studied directly from nature by the artist.

Should anyone desire to get a better idea of the tenets of the naturalistic school, I would refer him to Mr. Francis Bate's book, "*The Naturalistic School of Painting*," a fresh, direct, convincing little work which every photographer should read, and in parts re-read, and to which I wish to express my own indebtedness.

Under such principles have been produced paintings which have the power of moving a sympathetic nature-loving observer to the keenest of æsthetic pleasure, an ecstasy of enjoyment far beyond any satisfaction derived from "the fitness of symbolism" or decorative arrangement. Some may never have discovered this feeling for subtle representations of natural scenes, but no one is capable of estimating the respective merits of the old and the new, the power of such poetry as is shown in symbolical or decorative work as compared with the poetry of naturalism, who has not felt enraptured by the perfection of naturalness of some of these genuine impressionist paintings. There is a liveliness, an exuberance of joy, a yearning for a sympathetic companion to share the feeling of exultation, when one has happened suddenly upon a subtle fact of natural light, colour, air or form happily touched off, a curve of the beach, a boat seen from the shore level on a stormy day

over the crests of the surf, a broken bit of ground in sunlight, and the like.

It is only in the light of such views, then, that I care to examine or put forward the claims of photography, as, indeed, of any other method, to be admitted as a capable means of artistic expression.

Photography compels to much that is naturalistic. It has proved the keenest critic of conventionalism, and has exerted great influence upon the painter's art; influence, sometimes good or bad, individually, according to the knowledge and power, or the ignorance, of the painter influenced by it, but in the main tending towards greater truth and insight. In regard, however, to its own direct claim to be admitted as a means of artistic expression, it has only happened with the introduction and application to photography of these principles that any serious demand to be recognised in the domain of art has been made. Photographers have previously been rather inclined to accept the slur commonly cast upon their means and results as mechanical, and have exaggerated the limitations which their tools and technique impose upon them. They seem to have been unduly influenced by the patronage of some classes of painters, who have despised and condemned photography, partly with justice, seeing the average published results, and partly through ignorance of its possibilities. Photographers have accepted this degradation of their art, and have even joined voice in deprecating any reform or movement which promised better artistic expression as "apeing the conventionalities of painting." For example, some of the photographers of the older conventions have latterly objected to any but the most limited use of focusing for expressing the relative interests of a picture, and have even insisted that definition is the distinctive characteristic of photography. They have inveighed against rough surfaced prints as being in imitation of sepia drawing, appearances presumably held to be the sole privilege of the brush workers, and, whilst claiming for decorative, historical, imaginative, and symbolical painting the highest credit in art, they have disclaimed for their own medium any power or province in such work. Mr. Stillman holds that photography can have no place in art because design is impossible to it, and design he seems to define as "deliberate arrangements" carried out by hand. Mr. Pringle denies the possibility of what he terms "fine art" to photo-

graphy, or at least to any but combination photography by the peculiar distinction that he lays down when he says, "Art obtains where a painter simply paints what he has before him. This is not fine art." Mr. Gale finds the greatest happiness in what he alludes to as a transformation of nature and "those ideal representations which are the perfection of art," and, in this reference, he instances Turner's "Storm." Mr. H. P. Robinson approves and seeks to justify a wilful opposition between art and nature, and he goes with Mr. John Brett in demanding an improvement of nature, an exaltation of natural appearances, and an accentuation of beauties in pictorial representations, a position, perhaps, intended to justify combination printing.

There are other alleged limitations and defects, such as that photography cannot treat the sublime, that the nude is outside its scope, and a variety of cries all more or less included in the general exclamation that photography is merely mechanical.

In a very able and judicious report of the late Photographic Exhibition, the *Times* reviewer referred to the aim of the newer school of photographers to represent "the impression made on the artist's mind," and he said, "Here there are difficulties. The camera cannot select and discriminate. It cannot omit an ugly object or introduce a beautiful or suitable one. It cannot make those slight adjustments of the landscape which all painters do." Now this seems to suggest that the selection and discrimination is from something not in the particular scene in front of the artist. But the slight adjustments, the introduction of other objects can be no part of the impression produced on the artist's mind by that particular scene. There is a supposition in this view of an insufficiency in nature, and a necessity for what I have referred to as Mr. Brett's "improvement and exaltation of natural images." Those who adopt this view must look for their beauty and interest in some conventional cleverness of brush work or in the fitness of the parts for telling a story, and not to the subtle truth of the picture. One may readily admit a beauty, an intellectual triumph in a composition perfect in the fitness of its parts to tell a story or relate some historical incident, but this is a literary quality or it furnishes an antiquarian and didactic interest, and does not constitute the best, if at all the province, of pictorial art. The interest in such work and in symbolism is, as a rule, feeble and superficial for the nature student compared

with the absorbing and exquisite pleasure derived from a bit of simple, natural beauty, faithfully and spiritedly painted. For example, what is the interest and pleasure derivable from a mythological or historical subject? According to a man's familiarity with the literature of mythology, according to the extent that his mind has been absorbed by that particular lore, so he appreciates such pictures. Their seeming accuracy may please him. That is classical scholarship being taught and fed by painting; it is not æsthetic pleasure. The same holds with regard to historical painting. The artist may imagine vividly what a suit of armour he has studied would have looked like upon a soldier of the fourteenth century upon a certain battlefield. He may hunt up all the incidents, and study all the customs and costumes of the time and the occasion, and his research may be very creditable, but, after all, what value or subtlety can there be in such work? It is not the province of art to teach or illustrate history, nor, is it at its best with any didactic or moral aim. But even in historical pictures, mythological subjects, and the like, there may be something of the natural character, and this may captivate the æsthetic sense. There may be that in such work which, drawn from a study of nature, any and every observer can compare with his own experience. Whether it be figures or inanimate objects, all have gained some sense of their form, proportions, modelling, texture, and general appearance under many circumstances of light and atmosphere, and the chief charm lies in the life-like representation of these known appearances. The common criticism of the public in a gallery—"Oh, that's not natural; nothing like that was ever seen"—when quite unconventional, and not the product of hearsay, is generally the ultimate verdict upon such an imaginative picture, and coincides with the more completely cultivated and scholarly discrimination which discerns where and why the thing is not true. The naturalistic position, then, is that so far as a scene appeals to our experience of nature—harmonious and truthful in its light, atmosphere, relations, incident, and action—so far will it affect most powerfully our æsthetic sensibility, and such harmony and truth are only to be secured by a direct reference to nature.

Mr. Hamerton, in "The Graphic Arts," would make a distinction between truth and delight, but the naturalist, whether painter or observer, finds no opposition between the two

but derives the keenest of æsthetic pleasure from the faithfulness with which his own impressions of nature are expressed for him.

After all, nature is the best possible painter. Art has performed its highest function when it has enabled us to see "the eternal picture which nature paints in the streets," and has opened our "eyes to the masteries of eternal art." It teaches us to see the meaning, expression, and beauty—the poetry which lies in all natural phenomena, atmosphere and light, forms and actions. Emerson, in his essay on Art, says, "The best pictures can easily tell us their last secret. . . . There is no statue like this living man, with his infinite advantage over all ideal sculpture, of perpetual variety. . . . Men do not see nature to be beautiful, and they go to make a statue which shall be. . . . They reject life as prosaic, and create a death which they call poetic. . . . They eat and drink that they may afterwards execute the ideal. Thus is art vilified; the name conveys to the mind its secondary and bad senses; it stands in the imagination as somewhat contrary to nature, and struck with death from the first."

Turning to the general contention that photography is merely mechanical, this cry may be answered by a reminder that so may brushwork be mechanical; and it is sufficiently answered, I think, by the fact that the work of various photographers is as distinctively individual as obtains in regard to painters. Even leaving figures out of the question, two photographers separately treating the same subject will produce two impressions almost, if not quite, as different in qualities as would two impressionist painters in monochrome. It may be said that the painter is freer to generalize, emphasize, and analyze, as he may please; but if this is said of an actual scene in front of the artist, it must be remembered that the lens, as used by a trained observer, sees very much as the eye sees; and, that most of the suppression and selection possible to a painter genuinely consulting his impressions is also at the command of the photographer. Unnatural emphasis may please a certain school, but it will not bear comparison with nature, and it will in time have its proper value assigned to it. It is also said that one photographer can easily proceed to take exactly the same picture that another has achieved. Well, I do not think it has ever been done yet in respect of any photograph worthy of the name of picture. And supposing

it is so, cannot a painter copy the work of a fellow-artist? The mere fact of the means including more mechanism is not a disadvantage if the result be more truthful and life-like.

The *Times* reviewer finds difficulties—I am glad to notice that he does not say impossibilities—in the way of photography giving the impression produced upon the artist's mind. It may be advisable to look more closely into this. What is this selection and discrimination which is impossible to camera craft? What is it which is possible to the painter in monochrome, which is really an essential of good art, that is out of the power of the photographer? Leaving such vague references as "exaltation of natural images," can anything be definitely stated in respect of this rendering of impression; can the finger be placed distinctly upon any quality in handwork from nature—any power of the painter, excluding colour, which is absolutely out of the range of photographic possibility? Our impressions are made up of light and light values in relation to one another—colour, form, binocular vision effect, focus, perspective. The painter may not play with the tone or relative values of his subject and picture. He may not falsify what the eye sees in respect of focus and atmosphere, nor indulge in several points of sight. He cannot do much more than the photographer to express the relative interests of his subject, which must generally depend upon the point of focus of the eye. It will be said, "there is the power of emphasis." But how can the hand-worker, a genuine impressionist, emphasize what the photographer cannot? Does he gain anything by putting a little more gaudiness here, a little extra detail there, in the extreme distance beyond what the scene gives an impression of, as, for instance, in Mr. Brett's own pictures? Does he make his figures stand out more plainly from their background than in nature, emphasising dark against light, or light against dark, to make the ignorant stare, as in some of the wood engravings in our illustrated journals? This is nothing more nor less than falsity of tone. In criticising Mr. Seymour Haden's famous "Agamemnon" etching, Mr. Hamerton asserts that "art is not the slave of nature," and on the ground of some greater purpose he defends what he calls the false tonal values of the plate. What this greater purpose was he does not state, but it is interesting to notice signs of some uncertainty in his opinion, for he almost immediately proceeds to show that,

looked at from a certain distance, everything in the etching falls together into fairly truthful relation. If, then, it is admitted that emphasis by falsification of contrast or colour is not permissible, what is this discrimination which is so much insisted on? It would appear to be nothing more nor less than a seizing on those facts which most simply and directly give the spirit and character of a subject. The best of what is felt and thought to be "ideal beauty" is "abridgment and selection." This abridgment and selection is the broad treatment in painting, the effect that the eye sees, and the photographer has the means of seizing or subordinating the same facts by the power of focussing that he possesses over the lens. The *Times* reviewer says the camera "cannot omit an ugly object, or introduce a beautiful one, or make slight adjustments in the landscape." Well, as it is the question of impressions we are discussing, neither can the eye omit, or introduce, or adjust details. But it can go a few yards and find an infinity of delight where there are *no* ugly objects. And if the camera cannot cut out an ugly object the photographer can. Mr. H. P. Robinson does so, and makes *very considerable* adjustments of his landscapes, and Mr. Lake Price has contrived historical subjects not greatly inferior to much that passes in conventional art. Is it a figure that is to be introduced? Surely the photographer may select the best type. Is it a tree he wishes to change, a notice-board, or other incongruous object to remove? These are trifles when he has all nature before him with infinite scenes and beauties that require no trimming of details. The hand-worker can, if he deems it right, omit and add freely, but the balance is redressed by the consideration that the one labours for a prolonged time at one subject, whilst the other may seek many fresh inspirations in the same time. Too much emphasis is put upon this small limitation, which is really an advantage in photography. It is *the light* that is the first and foremost fact of any scene or picture—the colour, the action, and sentiment of the figures. A severe naturalistic refuses to alter and omit, for although so doing might introduce only small errors, a principle is involved. He feels that there is no occasion or excuse for it. He might make use of materials drawn from a variety of experiences—a cloud from this day, a figure from that field, a tree from yet another time and place; he might piece sketches together, sketches taken under altogether

different circumstances of light and atmosphere, and each sketch might be delightful in itself; but, consisting as they must, of impressions utterly inharmonious, he would have done far better to have studied and expressed the beauty of each subject as it appealed to him complete in nature.

Mr. Brett proposes to exalt all natural appearances by drawing on memory and foisting a recollection of one scene and object upon quite a different one. Surely he must see that the "choice and exquisite appearances of nature"—his own expression—are too good to be falsified by what is termed idealizing. Again the perfection that Mr. Gale finds in Turner's "Storm" does not lie in any exaggeration of natural phenomena, nor in any impossible piecing together of the characteristics of one kind of storm with another. It has its effect because, and so far as, the impression made upon us by natural appearances is spiritedly reproduced. There is so much of this rare quality in much of Turner's work that keen pleasure is derived from it, in spite of some exaggerations and inaccuracies. Something less vague than claims for emphasis and the exaltation of natural images must be advanced before justification for painting from anything but nature can be admitted. The artist's work always falls short of his impressions received from nature. He has never given as fully as they impress him, the pathos of human life, the radiance of the morning, the glory of the sunset. When he has achieved this, when he has succeeded in seizing for us one tithe of the splendour, the sweetness of nature, one single aspect and expression of the human face perfectly, as we ourselves know nature and life commonly, it will then be time to talk of improvement and exaltation of natural images, and to proceed to invent new combinations, which are to "surpass in delightfulness the real images."

I see no reason then why photography should not be used to express our impressions of natural scenes as well as any other black and white method. (I have, of course, all along intended that colour should be kept out of any comparison. The want of colour places a method altogether upon an inferior level.) Worked under the same conditions as the eye, or under conditions as nearly approximate as possible, nothing gives so truthful a record in drawing as photography, and nothing, in my opinion, when the proper means are used and the requisite knowledge is possessed by the

photographer, gives so delicately correct a relation of tones. It is to the proper use of the proper means at their disposal that photographers still need stimulating. The most important of these means are such as are directed to securing the proper light effect and relations of light values, and those which give the focussing and relative interests of the subject. In photography, the subject of focus has altogether overshadowed the more important matter of tone, for no one, except Captain Abney, has given this latter any scientific attention. It is impossible now to go into the subject of means and methods, but it is worth while noting that some of the simplest facts of light are overlooked by photographers, who have been governed by untrue and misleading conventions and dogmas concerning gradation and brilliancy. For instance, the necessity for points of the deepest black is insisted on, in order to give scope for as long as possible a series of steps up to points of white, regardless of the fact that this black is generally much too black for the purpose in hand. A little experiment would show how light outdoor shadows should be as a rule. For instance, the darkest shadow out of doors seen at a little distance is *lighter* than the shadow side of a *white* curtain in a room. Consequently it is of first-rate importance in landscape pictures to keep the shadows light. To repeat the impression of outdoor light the whole picture must be luminous, and not heavy and dark, as is the effect of the ordinary style of developing and the use of albumenised silver paper. Further, the shadows when the sun shines are lighter than when he is obscured. Or, again, there is the elementary observation that many objects seen against the blue sky come light on dark. The photographer has been so accustomed to obtaining a blank white sky on a blue day in his prints that he arrives at a conviction that this is correct. So much so indeed that it is related in the journals that the early photographers prided themselves upon their beautiful white skies, and would have no others.

In regard to focussing, again, there are, similarly, misleading conventions which prevent the free and general use of the full powers of photography. We still hear repeated the doctrine that minute definition is the distinctive quality of photography, and that, therefore, this should be made the most of in artistic work. Even if it were, it would be sufficient answer to this that such definition is not the distinctive characteristic of *seeing*. But defi-

nition is no more the distinguishing feature of photography than is exaggerated perspective, or, indeed, want of definition that is diffusion or softness. This depends upon the instruments used. We are told that in any broad treatment by focus we are imitating the natural characteristics of a certain school of painting. It might with equal force, or no force, be alleged that those in favour of minute definition are, in their sharpist tendencies, apeing the characteristics of the old miniature workers. Whether in painting or photography, it is purely a matter of the instrument used and the use made of it. In the one, either a fine point or a broad brush may be used. In the other, the optician's idea (a scientific aspect) of perfection in a lens is surely not expected to sway those bent on giving æsthetic pleasure. Everyone has seen that so-called mathematical accuracy is not necessarily artistic truth. Nothing but what observation or science can establish can be adopted as a principle by a naturalistic photographer. That the eye with one point of sight sees in different focus near and distant objects everyone admits; within what limits and with what differentiation is not so clear. If mere observation and feeling are of any weight, I should say that in some subjects the relative interests are given best with considerable differentiation, and in others the effect on the mind is best gained by general diffusion. I am aware that this is somewhat opposed to the very forcible argument in favour of one point of sight for focus as for perspective in any picture, but in many instances the difference of effect in the two treatments does not appear important, and is by no means easy to distinguish, even by expert observers.

A not unimportant consideration, bearing in some measure both upon the matter of values and definition, is the printing medium employed. I find, in the newest extra rough-surfaced papers, very excellent and distinctive qualities, in respect particularly of breadth and luminousness. Some extraordinary objections have been taken to the results on these papers as not being photography because they bear resemblance to wash-drawings; and one gentleman finds in this, and the character of diffraction photographs, an opening of the door to any and every kind of brush-work upon the print. But the answer is, first, that there is no aim to get wash-drawing appearance; and, secondly, all the process is pure photography. Both the photographer and the painter have the same aim, and it is not sur-

prising if printing upon the same papers produce similar results, for photographic deposit more resembles painted surfaces than any other method. Both work in tones, or shades of monochrome, and both may be worked upon any medium which promises to give more truly and more effectively our impressions of nature. It is certainly very refreshing in its audacity to be told that, because photographers have consented to smirch the fair name of their art by the general use of albumenised paper and small stops, therefore this is to be its character for ever. In some respects, the use of these rough papers, which are only now likely to become general for artistic work, constitute one of the greatest advances yet made. It need hardly be said that rough paper will not make a bad picture good or great, but it will do this: it will make all the difference to the majority of educated spectators between interested observation and contempt. It is difficult to over-estimate the importance of the printing medium, as far as the credit of artistic photography with the critical public is concerned. There is almost as great a superiority for most subjects in the new platinotype paper over the ordinary platinum surfaces, as there is between these latter and silver printing. This quality of the printing has more effect upon the casual tasteful observer than any other quality of the production. The defective printing medium has obscured the qualities of photography. The effect of prints upon such papers as I allude to at once shakes the superstition of honest critics, who have hated photography for its hardness, vulgarity, and untruth. These extra rough surfaces I consider the best printing medium that has been introduced, not excepting reproduction of the negative upon a copper-plate or photo-etching. Unfortunately, the difficulties in the way of quick production must probably leave the field of commercial publication to the photo-etching process. This leads me to say a word in comparison of photography with other black and white processes. It is admitted to have very justly been the death of line engraving. We have heard much about the interpretation of a painting by the engraver in black and white; but both painter and public who wish to see retained the original quality of the work, must prefer a photogravure to the hard, formal and unnatural character of the line engraving. Photography has pre-eminently more of painting qualities than any other monochrome process. Take etching, for example. Which is the better adapted for

reproducing natural effect—Photography or etching by line? Mr. P. G. Hamerton, in his standard work, "Etching and Etchers," compares etching with other arts, and finds the superiority of etching in its power to express form, and in its freedom, precision and power. He admits that "perfect tonality is very difficult in etching," and that other arts are better in the representation of clouds. He recognises that the brush is better than the point, because lines do not exist in nature, but he contends that painting is not quite so well adapted to the expression of transient thoughts. How does etching compare with photography in these respects? I venture to think even less favourably than with monochrome painting. Photography is not specially limited to, nor compelled to emphasise, facts of form. It gives form by means of tone against tone, and that is the best means of rendering it, and its truth of form is unequalled. In regard to tone, it is equal to any other black and white process, not excepting mezzotint, to which, indeed, it is often superior in respect of delicacy of gradation. This, of course, only refers to photography used at its best. We are considering its powers, not the average of its productions. The crude, ignorant workmanship that is so common is no fair test of its capabilities. For instance, let it be admitted that there are great difficulties in a large range of subjects in respect of rendering their relative light values, and the ordinary practitioner very rarely takes any trouble to overcome them.

Further, then, every observer knows the perfection of photography under suitable conditions of light as regards transient action and effects, and in nothing more than cloud forms is the delicacy of its tonal discrimination shown. But Mr. Hamerton would say that all this technical perfection—even if he admitted it—is useless, inasmuch as the camera is incapable of what he calls "idealisation of natural form, emphasis in lines, and concentration of natural light and shade." These very vague qualities, are, to him, the artist's especial and peculiar work. As I have already treated this matter to some extent, I will here only refer to the etchings in Mr. Hamerton's book for an example in illustration of my argument.

Some of the finest etchings in the work are photographic in character—using photographic in the best sense of giving true tone, drawing and simple naturalness without any playing with facts—such, for instance, as that by

Rembrandt ("Rembrandt drawing"), those by Lalanne, and in part that by Whistler. Referring to the Whistler etching of "Billingsgate," Mr. Hamerton notices, with just appreciation, the observant work in the buildings on the quay, and he refers to the harmony in the festoons of the converging cables of the boats as approaching poetical synthesis. I should prefer to call the rendering of these festooned cables a bit of most natural analysis. It is the result of close observation, with a marvellous power of expressing the leading facts exactly as we know them and as Whistler saw them. The exquisite pleasure that this bit of the drawing gives is due to the natural way in which the impression of ropes forming long curves away from the eye and dipping in the stream is reproduced with a simple touch. In short, it is artistic truth—the truth that the artist wanted, unencumbered with local facts of which he would not be conscious save by scientific examination. This is true imitation, an exact hitting off of the leading fact, a power thought to be easy and mechanical, but one as rare in graphic as in literary art. Photography may never have yielded such subtle and exquisite analysis as this, and as the suggestion of heaving water, but photography has yet to get its Whistlers, and it works in a manner very different from etching. In the same etching it is strange that there should be such evidence of slovenliness and want of observation in the character and the form of the boats, which are egregiously unlike any vessel ever found at Billingsgate or elsewhere. Perhaps this would pass for exaltation of the natural images with Mr. Hamerton, but it would be painful to those educated by observation of the character of the objects.

Mr. Hamerton would have conferred lasting credit upon his insight had he, against the rigid prejudices of the time, been able to recognise the just claims of photography, and had he included for comparison in his book, "The Graphic Arts," an example of photography at its best. Others, at any rate, are now able to see its power for expression of artistic feeling, a power budding under naturalistic influences and a more severe scholarship in the *technique* of the art. If the power of expressing artistic impressions by photography is impossible, then must all the work of the naturalistic school of painters be excluded from the pale of graphic art, for theirs is confessedly "an honest attempt to paint what they see," and photo-

graphy, artistically employed, has the same aim.

Concerning photographs bearing somewhat the naturalistic character, that is, with truth of tone and suppression of unnatural detail, it is no uncommon thing to hear it said, "Oh yes, they are artistic enough, but they are not photographs." Such is the domination of conventional views. I believe, indeed, that some of our friends are prepared to accept this view, and we have an ingenious suggestion that as there are painter-etchers so there should be painter-photographers, a name to be accepted, I presume, either on the *lucus a non lucendo* principle that all painting is rigidly excluded from their plates and prints, or to proclaim that they gladly admit the soft impeachment that their photographs are guilty of looking like sepia drawings.

Be that as it may, I will now only say in conclusion that it is such work that has been most instrumental in breaking down the widespread prejudice against photography as an essentially mechanical, harsh and vulgar medium for anything like artistic expression, and that it is in that direction we shall have to look for its elevation to its proper place amongst foremost black and white processes. It is from no mere formula of fuzziness or definition that the best work derives, or can derive, its quality; but from the acquisition of artistic facts by observation and experience, facts of light, the limitations in black and white work, the relation of light surfaces, orthochromatics, relation of objects in respect of focus or mental interest, study of form, action, and typical character, the use and application of lenses, knowledge of the subtleties of development with the relation of exposure thereto, and the study of the qualities of printing processes. This is no question of months, but a matter of years, before a man can hope to see clearly what it is he wishes to express, and move freely in expressing his impression. We need not be discouraged that unnatural "exaltations" and combinations are impossible to us. The quality of naturalness will tell in the long run. Men will weary of emphasis, and graphic artists will leave past history, archæology, and fiction to literature or scientific drawing. The keenest æsthetic pleasure is to be derived from the spirited truthful rendering of character, whether in face, figure, or landscape. The things of to-day will be of deeper interest to-morrow. As Emerson says, "It is in vain that we look for genius to reiterate its miracles in the old arts;

it is its instinct to find beauty and holiness in new and necessary facts, in the field and roadside, in the shop and mill." The scope of photography is extended. Nature will never go out of fashion. Prejudice will fade, and even one generation ahead will find the value of photographic portraiture, if it be natural and permanent, as it may be. The prospect is worthy of work, devotion, and sacrifice, and, in our enthusiasm, we may be forgiven for indulging visions of a time when, with Truth and Nature as its watchword still, photography shall have taken to itself such glorious attributes, that with fewer limiting conditions, our every impression of the visible world, light, colour, action, and form will come within its scope to express.

DISCUSSION.

The SECRETARY read the following letter:—

13th November, 1890.

"DEAR SIR TRUEMAN WOOD,—I have this moment only received your obliging letter of the 27th ult., asking me to preside at a meeting of the Society of Arts on the 17th Dec., when Mr. Davison, you tell me, is to read a paper on 'Impressionism in Photography.' I greatly regret that the state of my health and my inability to be in town on the 17th will prevent my being even present on the occasion you mention, all the more that I am a great admirer of Mr. Davison's work, and fully recognise in it the possibilities of a somewhat arbitrary process in the hands of a true artist; and, again, I should have been glad of the opportunity which such an occasion as your meeting would have given me of mentioning to those present what I consider a somewhat remarkable experience of, shall I say, mind over matter? Last year (1889) I picked out of the Photographic Exhibition as many as eighteen exhibits which seemed to me to manifest an artistic quality distinctly personal and separate from those qualities which would be commonly understood as good photography, perfect definition and the like, and left the list with the attendant, that he might procure for me such as were saleable. I did not get one of them, and on going to the gallery this year learnt the cause of this, which was that they were 'all by amateurs.' I make no comment on this, nor do I pretend (myself, I believe, a despised amateur) to anything like an authoritative expression of opinion on such a point; but this I do think, the incident clearly proves, namely, that two different and distinct qualities existed in these eighteen examples, the minor quality (so far as it went) of good photography, and the greater quality (so far as it went) of genius—poetic or painter-like—whichever you may like to call it. I should not wonder if it were chiefly on this

latter quality that Mr. Davison means to speak on the 17th, and I repeat I greatly regret that I cannot be present to profit by what he has to say.—Believe me, dear Sir Trueman Wood, yours very faithfully,
"F. SEYMOUR HADEN.

"Sir H. Trueman Wood, &c."

Mr. DALLMEYER said this paper would be welcomed by everyone interested in the progress of photography. Mr. Davison had gone beyond most in suggesting that it might surpass all other forms of art in black and white, but he (Mr. Dallmeyer) regretted that he had not spoken at greater length on the optical aspect of the question. He was glad to find that Mr. Davison based all his theories on submission to science, and admitted that naturalistic ideas must be subject to scientific investigation. They had heard similar views before from Dr. Emerson, who contended that what he called naturalistic focussing was a parallel to the impression produced on the eye in ordinary vision. It was said that many photographers claimed sharp definition as the main character of photography, and that was quite true, because no other process would give that when desired. The optician's effort was to obtain the highest degree of accuracy possible, and the object of the naturalistic school seemed to be to so utilise the lens as to throw the picture a little out of focus, and thus imitate what was seen by the eye. A great deal had been said about the introduction of spherical aberration into lenses to effect this end; but even if that were done, it would be a question whether the quality and definition so given would be true in tone, and it would be for authorities on the subject to decide whether the effect would be as good in that respect as that obtained with an aplanatic lens somewhat out of focus. In any case, if spherical aberration were introduced, it must be consistent with other requirements, covering power, flatness of field, and so on. He would suggest to those who wished to produce artistic effects the use of double backs, giving to one plate the finest definition they could, and then, after shifting the focus, using the other double back, and comparing the results. Observation showed that in the naturalistic method of focussing, it was the larger aperture which gave the differential emphasis of varying planes, somewhat parallel to the phenomena of binocular vision. If the foreground object were of interest, the emphasis laid on that would be very much greater in comparison than if it were at a considerable distance; the farther off an object was the less was it affected by the parallax of binocular vision.

Mr. MASKELL said Mr. Davison's paper was a plea for the application of impressionist feelings or naturalistic principles to artistic photography. He had spoken temperately, and without exaggeration,

of the conventionalism and symbolism found in earlier schools of art; but, admitting the beauties of the modern methods, we must beware of treating the wisdom of ages with contempt. In the graphic arts as in literature, in painting as in poetry, it would be long before the conventional, the symbolical, and the imaginative were thrust into the background and replaced by absolute truth and realism. Was there to be no pleasure in reading such works as, for example, those of that highly imaginative writer Théophile Gautier? Ought they to give a higher consideration to Mark Twain's impressionist descriptions, accurate though they were. In painting also, was the worth of G. F. Watts or of Burne Jones to be dismissed as wanting in the highest expression of art? He had much sympathy with the newer schools of art, and especially in their relation to photography he considered their influence as hopeful; but to admire the new it was not necessary to decry and depreciate the old. The influence of the impressionist school was gaining ground every day, even amongst the Philistine public, as might be seen even in periodical illustrated literature. Look at *Scribner*, and *Harper*, the *Graphic* and the *Illustrated Christmas numbers*; and the drawings in these periodicals by Townshend and Bernard Partridge, for instance. They were like wash drawings in sepia: vague, suggestive, out of focus. Would the public delight in them if their taste had not been gradually trained to appreciate them? In photography, also, the impressionist school had taken hold of the public to a far greater extent than admirers of the old style would care to admit. It was not altogether a question of focus, though that had a great deal to do with it. With regard to conventionalism, photography is an art which, more than any other, had a right to demand to be less trammelled. It was by its own nature already so bound by mechanical restrictions, that in every direction in which it could possibly escape, so much the more was it likely to show its power. That the revival in photography had as yet produced any great work it would be hardy to assert, but the promise for the future was very great, and he felt certain that time only was wanting to produce from the students of to-day the artists of the future.

Mr. W. E. DEBENHAM said it seemed to him that the arguments in favour of blurring in a photograph were founded on one or two radical misconceptions. The first arose from the two meanings of the word "sharp," which, in the case of photography, meant well-defined, and was quite compatible with softness; but a painter, when he used the word, referred to contrasted masses of light and shade with accentuated outlines. He had heard a photograph condemned by a painter as too sharp, when photographically it was not sharp at all. This point was illustrated in one of Dr. Emerson's pictures, called "Barley Harvest." Photographically, the sharpest

part of it was the corduroy trousers of the man sitting on the ground; these were very well defined, though soft; but there was another part of it which a painter would call sharp, where the scythe and the men's head and figures cut against the sky. Being dark and heavy in tone, there was a sharp contrast. This part of the picture was, however, not photographically sharp—not in focus that is. It was assumed by Dr. Emerson, and he understood it to be endorsed by Mr. Davison, that photographic sharpness, fine detail that is, emphasised the part of the picture where it existed, and caused it to be regarded as the leading theme of the picture. If this was so, the corduroy trousers must be looked upon as the theme of the picture, but if this detail did not have this effect, but the sharpness—using the word in a painter's sense—of the scythe and figures against the sky, did produce a contrast of light and shade, he would like a reply to this argument against fine definition. The next misconception arose from a confusion as to the extent to which we saw various objects out of focus at the same time; and on this point it would have been better if Mr. Davison had been a little more definite. If you looked at an object a few inches off, and at another many yards away, you could not see the two simultaneously with any distinctness; but if the nearest object were some 30 feet away, another object at any greater distance, but in the same part of the field, would not require any perceptible alteration of the eye to get it in focus. To what extent the eye differentiated objects at a distance, and how far the lens in a camera could do the same, depended on the size of the diaphragm. It was the absolute size of the diaphragm, not its proportion to the length of focus, which gave objects at different distances the same amount of distinctness; and it followed that to imitate the effect on the eye, the stop should be the size of the opening in the iris, say 1-8th or sometimes 1-4th of an inch. Again, to produce effect without fine detail in a photograph, and in a picture, you stood on totally different ground. In a photograph it only required care in focussing, a very small stop, and a long exposure. The painter did not introduce detail which at viewing distance would not be observed, but neither was such detail observed in the photograph at viewing distance. The painter, by a few touches, could give the characteristic form to angles or leaves which the out of focus lens could not. If it were a little out of focus all angles became rounded, and thus the whole effect of a branch of a tree or foliage was gone. The most impressionist painter would not represent angular forms by circles, but would put in a few characteristic touches which would give the form. He could not see, moreover, that the appropriation of the term "artistic" to photographs out of focus was justified. It might be that artists did not give such fine definitions generally as a photograph would give on its best plane, but they generally gave better definition throughout than a photograph would at any part except that specially focussed, unless very small stops

were used. Alma Tadema's pictures had been mentioned, and he remembered that it had been said that that artists' paintings were almost as sharp as a photograph. As a matter of fact they were much sharper than a photograph of the same subject the same size could be obtained, except on one plane, and that was characteristic of painters generally. He fully recognised the artistic character of Mr. Davison's work, but thought it would be still better if he would use smaller diaphragms, and give better definition generally—in most cases certainly. He did not look upon him as at all an extreme advocate of blurring. To insist on blurring generally seemed as reasonable as to say that every artist should finish his painting by going over it with a badger brush to give it artistic softness.

Mr. J. FLETCHER MOULTON, Q.C., F.R.S., said he took great interest in this subject, though he was quite ignorant of the technique of the art. He cared nothing for the means people used, but a great deal for the effects they produced, and looked at the matter from the point of view of the British public, who knew something of the pleasure of art, and wanted to see which of the two rival schools could give them most of that pleasure. He sympathised with the reader of the paper, who claimed for photography a place amongst the means of artistic production, and if photography did not come forward boldly and make the claim, it would never receive its proper recognition. He agreed largely with those who said that the best art teacher was nature, but he could not see that there was any necessary exclusiveness in regard to the production of art in faithful imitation of nature. He valued more highly the production of a great mind filled with poetry and imagination than the most perfect copy of even a beautiful bit of nature. It was only bigotry to suggest that you could get no beauty except by imitating those things which by chance or design came together in nature. Photography was absolutely debarred from imaginative art, but there was no reason why it should not do as valuable work in that department which went straight to nature. It could not claim a high place merely for its accuracy; if it only gave an accurate catalogue without calling up the associations belonging to the subject it was not artistic. That was what photography had been content with too long, and from that reproach persons like Mr. Davison were trying to rescue it. The question was, were they going the right way about it? He felt sure that a man did not get nearer to nature by blurring a good picture. He did not believe people did see things blurred, unless they were shortsighted, and then they sought the aid of the optician. Many people seemed to think that a picture which was blurred, either by rough paper or bad focussing, was a step in the way of art, but he could not agree with them. It was not more beautiful, and certainly

was not more like nature. At the same time, the old photographs were not quite the right sort of thing. There was a painful, obtrusive accuracy about them which did not look like nature; but it was not to be got rid of by blurring, which was only a trick. They underrated the sensitiveness of the eye to light, and the peculiar paralysis of the optic nerve which came from bright light. We did not see those startling contrasts of light and dark except momentarily, then the excessively bright light was dimmed, and thus, though the former were not blurred, the contrasts of light and shade became blurred very rapidly, because the eye could not tolerate them. This could be seen very well in looking at a fine sunset. Taking the picture which had been referred to, he did not think the corduroy trousers would have a brightness which would fatigue the eye, but some of the brighter points of the picture would fade; and he rather thought the real defect in the old photographs was that they were too faithful in recording the contrasts of light and shade rather than that they gave the outlines too sharply. He did not think there was any short cut to artistic truth by taking up any trick which was in the nature of a defect. The tradition of too harsh an effect might be broken by passing through this stage; but he did not think Mr. Davison, and those who sympathised with him, would rest there. No one with real artistic taste would allow himself to be deceived by mere imperfect work.

Mr. JOHN LEIGHTON said he read a paper thirty-seven and a half years ago in that room upon photography, Sir Charles Eastlake, President of the Royal Academy, presiding. Photography was then getting a strong child; it was the day of waxed paper and box cameras. Collodion had not been invented, and photographers were all trying to get away from haze and effect, and to produce maps and detail, by stops and over-focussing. Photography was then pure in one sense; touching was unknown, and the effect obtained was that of nature, and as such, of value; now, all blemishes and wrinkles were stopped out, until a sort of typical wax-like image was obtained, flattering to all. He recollected a most laudable attempt of Mr. Smee, F.R.S., to produce, by binocular perspective on one plane, a picture by taking buildings by a moving camera, and he (Mr. Leighton) applied the same system to portraiture. During the taking of the picture the camera being shifted backward and forward, this produced more or less haze upon those parts in front and behind the plane of vision. In nature no two planes of vision can be seen at once, though the eye can flash about and make one think so. Impression is the one vision that should be the happiest, the broadest, and the most characteristic. Photography ran art much closer now than in 1853 he thought possible, whilst as to action, it had settled many problems of infinite use, perfectly unknown to art, which worked by instinct alone.

Mr. PHILIP H. NEWMAN said he had always endeavoured to maintain that in the hands of an artist the camera might be made a means of expression, the artist seizing upon some phase in nature to photograph which lent itself most directly to pictorial treatment. He saw no necessity for tampering with such a picture optically by putting any parts of it out of focus, or straining the perspective in any way. The camera, after all, was the most mechanical of all artistic appliances, and should not be used to effect results more easily obtainable by pencil, chisel, or graver. It had its own special metier and advantages, its greatest boast being its faithful delineation of detail. It seemed to him that those who desired to obtain an intellectual impression, or sketch, by the roundabout method of photography, were practically throwing away a tangible and literal substance, for an intangible, if intellectual shadow, in trying to imitate the function and object of another art. Impressionist results in photography were exaggerated as much as possible by printing on very coarse paper, which was in itself a mistake; as grain or rough surface in works of art was a matter of scale. The *reductio ad absurdum* of printing a *carte de visite* on very rough paper would prove this at once, without dwelling on the fact that Gerard Dow, Teniers, and Van der Heyde, did not paint on coarse canvasses. Impressionism in photography, by its abnegation of detail, involves an amusing paradox, and might be looked upon by some as a craze of the moment, but the position of photography, and its growing value to the masses as an art teacher, required it to be treated seriously. Much as he admired Mr. Davison's work in general, he thought his new departure was on wrong lines, for he could not see that the highest attribute of one art, photographic or otherwise, lay in its more or less imperfect imitation of another. All artists will admit that the greatest use of photography was as a handmaid to art, and all would recognise her services. But the art of photography lay in the choice of subject, which must be made or arranged irrespective of lens or focus.

The CHAIRMAN, in proposing a vote of thanks to Mr. Davison, also expressed the acknowledgment of the Society to Mr. Lucas, Mr. Cameron, Messrs. Faulkner, the Platinotype Co., and others, who had kindly lent works of art to illustrate the paper.

The vote having been carried unanimously,

Mr. DAVISON, in reply, said he could not attempt to answer all that had been brought forward, but he would give the arguments adduced his best attention, and hoped to profit by them in future.

Miscellaneous.

THE CORK INDUSTRY IN SPAIN.

The cork tree is found in Spain in great abundance in the provinces of Gerona, Cárceres, and Andalusia, especially in the provinces of Huelva, Seville, and Cadiz, and, although in less quantity, in the provinces of Cuidad Real, Malaga, Cordoba, Toledo, and some others. The United States Consul at Barcelona says that, according to a calculation made by the administration of forests, the extent of cork forests in Spain is about 255,000 hectares (hectare = 2.47 acres), distributed as follows:—80,000 in the province of Gerona, 45,000 in Huelva, 32,500 in Cárceres, 28,000 in Seville, 20,000 in Cadiz, 11,500 in Cuidad Real, and 9,500 in Cordoba. In the localities exposed to the north the cork is better than in those exposed to the south, and it is seldom found in calcareous soil, preferring always that of the felspar, this being found principally in the province of Gerona. It grows and develops in ground of very little depth, and sometimes in very stony ground. The leaves of the cork tree are oval-oblong or elongated oval, frequently toothed, and the teeth jagged; length, from three to five centimètres, and width from one and a half to two. The roots are strong, and spread considerably, and are frequently to be seen on the surface of the ground. It sometimes happens that the portion of root exposed to the air produces cork, while that which is buried produces scarcely any. The most common practice is to cultivate the plant by sowing, which is frequently done, especially in ground somewhat manured, making alternate furrows with vines. Up to their twentieth or twenty-fifth year the ground is cultivated as if it were a vineyard, rooting up at that age the vines on account of producing less fruit, and also on account of the cork trees being fairly grown up, and no longer requiring the shelter of the vines. The barking of the cork may be effected when the plant has acquired sufficient strength to resist the operation, and the time chosen for this operation is in the summer. The cork of the first barking is called *corcho bornio*, *bornizo* or *virgin*, and is not fit for making corks. The cork taken after the first barking is called *pelas*, or secondary cork. The method employed in Spain for this operation consists in the total barking of the trunk, and not partial barking, or barking one part of the year and the remainder three, four, or five years later. In proportion as the cork is taken from the tree it is removed and piled up in heaps. Sometimes the cork is cooked in the woods, but at other times this operation is effected in the cauldrons that exist in the cork factory. The slabs remain in boiling water during the space of one hour, this

operation causing an increase of thickness (generally of one-fourth to one-fifth), elasticity of the cork, and dissolution of tannin and other substances. The cauldrons in which the cork is boiled are of copper, and are either cylindrical or rectangular. The boiling of the cork can also be effected by steam, for which purpose it is introduced into a wooden box lined on the inside with copper or zinc, which is filled with water and steam injected therein. The steaming of cork sometimes hardens it and makes it brittle. The loss of weight produced by boiling the cork varies between twelve and forty per cent. In making corks it is necessary to take away the hard crust or *raspa*, for which purpose a tool is used with a short handle and curved blade, called *doladera*, *rasfador*, or *raspeta*. A workman can scrape from two to three square metres of cork daily, and the loss in weight of the cork by scraping is from twenty to thirty per cent. Scraping machines are also used, two systems being employed, the Besson and Tousseau. The former, propelled by steam, consists principally of horizontal spindles, supplied with comb-like teeth, and turning with great velocity, at the rate of nine hundred revolutions a minute. The Tousseau scraper attacks the cork by the means of a vertical iron shaft, carrying several knives, whose edges are also vertical, and by the rotary movement of the shaft, giving fourteen hundred turns a minute, work like a brush. This machine is simpler than the Besson, and the slabs suffer less damage when worked by inexperienced workmen. Before cutting the slabs in strips they are cooked for about half an hour, so as to facilitate the cutting, and piled up soon after in a damp place, so as to preserve the softness until ready to operate upon. The slabs are divided into three strips (*rebanadas*), the width of which is equal to the length of the corks, and in such a way that if the cork be placed in the position occupied by the slab on the tree they would have their fibres running alike. The workmen obtain or cut the strips by means of a knife with flat surface and curved edge, called *cuchilla de rebanar*. The strips are then made into squares by means of the *cuchilla*. They then have the edges cut, and thus prepared they are ready to be made into corks. This and the preceding operation are the most difficult of the cork industry, requiring great intelligence if the slabs and strips are to be cut to the best advantage. In the manufacture of the corks, the squares made into octagons first pass into the hands of the workman, who is furnished with a knife composed of two pieces, one of them similar to an ordinary knife and the other a blade the edge of which fits into the first. Consul Schench says that only by seeing is it possible to form an idea of the rapidity with which these men take hold of a square and from it make a cork—they hold the knife by a small iron catch to the table in front of them, and giving to the square a circular movement the result is that the cork is made in a few seconds. The squares are usually boiled for

about a quarter of an hour, they are then deposited in a cool place, and four or five days after they are sorted and kept damp until required. The amount which the workmen receive for cutting 1,000 corks varies from 0.75 to 4 pesetas, according to the kind of workmen (the peseta is equivalent to about 9d.). Different systems of machinery are employed to make corks, and all consist, at the base, of a knife, the blade of which is placed horizontally, joined generally to a piece of wood, and to which a back and forward movement is given similar to that of a carpenter's plane. In moving, the knife turns the square cork, which being attacked by the knife takes off a strip of cork, more or less thick, according to the distance from the axle of the cork and the edge of the knife. If these are parallel, the result is the cork is cylindrical, and if it is not it becomes conical. The corkmaker or workman has a large basket or several of them in which he places the corks according to size or quality, but this first classification is not sufficient, and the corks are placed upon a table, the back part of which is furnished with boxes the front part of which are open to the operator. To classify the corks according to size, they also employ wooden boxes, the bottoms of which can be taken out or put in, having a kind of grating of wood somewhat resembling venetian blinds. The boxes are suspended by ropes to the ceiling, and the workman gives it a swing backwards and forwards, by which the smaller corks drop out at the bottom. With this apparatus worked by one man, 100,000 corks are classified for their size in one day. The corks are washed in a solution of oxalic acid or bioxalate of potash. As soon as washed they are placed out to dry gradually in the shade, in order to enable them to retain the silky gloss which the cork has when it is damp. For packing, 30,000 corks constitute what is called a bale. For South America and Oceania, bales consisting of 5,000 to 10,000 corks are made, and for England the sacks or bales are made to contain 100 gross or 14,400 corks for those of the larger size, and 150 gross for those of smaller dimensions. The greatest number of corks are manufactured in the province of Gerona, and the most important towns engaged in the industry, are San Filieu de Guixols, Palafrugell, and Cassa de la Selva. The number of workmen engaged in the cork industry in Spain is said to be not less than 12,000.

AMERICAN TINNED FRUIT.

About one million tins of fruit are put up annually at Cincinnati, principally peaches. As these tins are air-tight, the fruit is preserved in an almost perfectly natural state, and in its own juice. When a sufficient number of tins are filled, ready to boil, cold water is filled in. If sugar is used, it is better to heat or steam the fruit, without adding water, filling the cans, as they come from the fire, with a syrup

made by dissolving the sugar in boiling water. If motives of economy are practised, it is better not to sweeten the fruit, except pears and peaches, whose flavour is improved by it; for the fruit will not keep any better. The time required for boiling whole peaches is fifteen minutes, and half peaches eight minutes. The proportion of sugar to be added to the pint, is 4 oz. to the quart. The quantity of fruit preserved in its own juice, annually received in England, is now very large.

In the United States, Baltimore, Rochester, and New York are the chief centres for preserving fruits. The value of the American fruit—preserved in cans, or otherwise—exported ranges in value from £154,000 to £200,000 annually.

At the last Paris Exhibition, specimens of American candies and confectionery, made by hand and steam-power, were shown from New York, Buffalo, and Philadelphia. One maker from New York exhibited no less than 3,000 different styles of bonbons and fancy chocolates.

In 1887, the canned fruits sent from California amounted to 792,500 cases of about 45 lb. each; of these, 220,000 cases were peaches, 175,500 of apricots, 150,000 of pears, 60,000 of cherries, 40,000 of plums, 25,000 of blackberries, and 15,000 each strawberries and gooseberries. Of dried apricots, there were sent 3,000,000 lb.; of French plums and dried plums 1,750,000 lb.; of evaporated apples, 550,000 lb., and of evaporated peaches, 1,250,000 lb.

Under a patent of Mr. Campbell Morfit, of Baltimore, the juice of currants, lemons, oranges, and other fruit is preserved in bread. The juice, with or without sugar, is mixed with any kind of meal and baked into cakes. These are afterwards ground up and used to make a very palatable fruit farina. The fruit juices are said to retain their original flavour and character indefinitely.

For some years great attention has been given to developing the sale of preserved fruits. At first they were prepared on the evaporation system, and the fruit was then packed in boxes. This industry has had an enormous development, and the manufacturers of tin boxes in California are considered among the most skilful and the richest in the world. Since 1887 the yield of fruit has been so abundant that the special apparatus for artificial evaporation have been insufficient, and recourse has therefore been had to natural evaporation by solar heat, but the latter system has not given everywhere satisfactory results. In the greater part, however, of California, the air is extremely dry, and the desiccation of fruits under the influence of the sun is absolutely perfect. Of various fruits preserved without sugar we import 36½ million pounds, valued at nearly £300,000, chiefly from France, Italy, and the United States.

Fruits are preserved in bottles, either in their own juice, with a little water, in syrup, in brandy, and also in *noyau*. They are so preserved that the skin of the fruit is little broken, and the flavour scarcely impaired.

Many so-called jams and jellies, however, derive nothing but their name from the fruit from which they are professedly made, consisting mostly of apples boiled to a pulp, gelatine, glucose, &c., flavoured with essences. Apple butter, which forms a standing dish in most American houses, is a kind of jelly of apples boiled down, either in cider or with water, for several hours.

The preserved lime comes chiefly in small kegs, of about seven pounds weight, from Brazil. The natives have a method of removing the pulp, and afterwards preserving the rind dry with a thin coating of sugar. In the Levant there are many dried, candied and preserved fruits, which enter largely into commerce, some of which might be worth the notice of our dealers here. Among these are Symrna dried pears, Cyprus dried cherries, and Damascus dried and preserved apricots and apricot pulp. Among the Turks the strawberry is preserved into a conserve with rose leaves, and it is said to be very refreshing.

TREES IN LONDON.

From a sanitary point of view, it is generally held that trees are useful, though some maintain that, near houses, they are often harmful from their shutting out sunlight. Whatever may be the relative value of different views put forward, observations made within the last few years seem to establish the fact that within a five mile circle from Charing-cross the amount of foliage is decreasing. Many of the main roads leading out of London have been planted with trees; and largely, through the influence of the Metropolitan Public Gardens Association, many open spaces have been beautified by foliage. But while the number of trees placed on public ground is increasing, both the number, and, through very close lopping, the size of trees on private ground is decreasing. And the gains are far outbalanced by the losses.

The losses may be grouped under two heads.

1. The cutting down of trees completely. This is mostly due to clearances for building; and within the five mile circle the destruction of trees in pasture lands is small compared with the breaking up of gardens. In many parts houses standing in from one to two acres of ground are demolished for rows, or closely packed semi-detached villas, and the gardens are destroyed to make way for them. Recent changes in the Heme-hill district are a good typical example of this. Where three years ago there were around country houses grounds rich with timber and fruit trees, are now roads closely built on either side, with a few square yards of front that might be effectively treated with tiles and small pattern "carpet bedding," but are not large enough for trees. Instances of this kind might be quoted from many districts around London. Again, the older roads of villas, that had some 25 to 40 feet of

garden between the front door and the gate, with more at the back, are in all parts, little by little, being bought up to make streets which have their frontage flush with the pavement, or a depth of some three to four feet at the most railed off. The miles of plain fronted brick terraces built from 70 to 100 years ago are (probably as the leases run out) being replaced by rows with their front doors leading directly from the pavement. Architecturally there may be an improvement, but the gardens, which average about 30 feet in length, are lost. Front gardens are gradually disappearing from London, and with them go the trees that used to make the public ways so changefully pleasant from bright spring to rich tinted autumn.

2. In districts where gardens remain, there is a large increase in the cutting down and close lopping of trees. It is difficult to assign the cause for this; but whatever the explanation, the fact remains that the trees, instead of being annually pruned, are suddenly lopped till, in hundreds of cases, they are reduced to a trunk and a foot or two, or a few inches, of branch-stumps. Few trees grow symmetrically except when isolated, and, even then, prevailing winds have their influence, and in towns rows of buildings have an effect similar to copses and hill contours in protection. And in many cases around London, there may be seen trees so carefully tended from year to year that they but little overhang flower beds, grow well above the pavement, and yet do not look unnaturally distorted.

Many fine elms and spreading poplars and acacias may be seen, their trunks covered with ivy or other creepers, and the lower branches carefully removed, so that sunlight falls on the small garden, and the lower rooms have light. It would seem that want of management while trees are young is one of the causes of ignorant lopping being resorted to; and another, that forest trees have been planted where fine-leaved and small-habit trees would have been more appropriate.

It can be easily observed that the increasing number of public trees are periodically attended to, while private trees are disappearing piecemeal, or being entirely swept away. London has, in the last few years, gained in planted open spaces, but the acreage does not equal the small lawns, grass plots, shrubs, and trees lost.

Notes on Books.

APPLIED GEOGRAPHY. By J. Scott Keltie.
London: George Philip and Son. 1890.

This may rather be regarded as an introduction to the study of commercial geography than as a text-book

of the subject. The book is a reprint, with additions, of an article in the *Contemporary Review*, together with a series of lectures given by the author before the Bankers' Institute. The first two chapters indicate what Mr. Keltie regards as the field of geography—specially commercial geography; the others illustrate its nature by special examples. First, Africa is taken, and a sketch given of the commercial geography of that continent, showing the points which would have to be dealt with at length in a more detailed work, and indicating by special examples the importance of the subject. Then the British Empire is treated in a somewhat similar fashion, whilst the final chapter deals with some of the chief commodities of commerce (wheat and wool are the principal mentioned), and shows what their geography (if the expression be permissible) is. It will be seen, therefore, that the work may be recommended to those who are desirous of fixing their ideas upon the subject, and of ascertaining clearly what is the true scope of that new branch of an ancient science, commercial geography.

Obituary.

WILLIAM HALLOWES.—Mr. William Hallowes, who had been a member of the Society of Arts since 1849, died on the 3rd inst. at his residence, No. 32, Tavistock-square, in the 89th year of his age. He was the sixth son of Colonel John Hallowes, of Ashford, Kent, at which place he was born in the year 1802. In 1843 he married Elizabeth, younger daughter of William Tooke, M.P., F.R.S., who was President of the Society of Arts in 1862. Mr. Hallowes acted for some years as honorary solicitor to the Society.

General Notes.

CHICAGO EXHIBITION, 1893.—The number of *Engineering* for the present week will contain plans showing the arrangement of the buildings of the Lake front portion proposed for the Chicago Exhibition. This part of the exhibition, as readers of Mr. Dredge's paper will remember, is situated in the middle of the city, on the shore of Lake Michigan, close by the harbour. By the courtesy of the editors of *Engineering*, it is hoped that the illustrations may appear in the Society of Arts' *Journal* next week.

Journal of the Society of Arts.

No. 1,988. VOL. XXXIX.

FRIDAY, DECEMBER 26, 1890.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATION PRIZES.

The Council of the Society have determined to offer the following prizes, in connection with the Society's Examinations for the year 1891, out of the funds which have been placed at their disposal for the purpose by the Worshipful Companies of Goldsmiths, Mercers, and Salters:—A first prize of £3, and a second prize of £2, in each of the following subjects: English, Commercial Geography, French, German, and Portuguese.

The prizes will only be awarded to candidates who have taken first-class certificates, and are certified as proficient by the examiner in each subject.

In addition to the above prizes, the Cloth-workers' Company offer first, second, and third prizes, of £5, £3, and £2 respectively, to candidates obtaining a first-class certificate in Italian or in Spanish.

The above prizes are additional to the Bronze Medals, which will be awarded to the candidates obtaining the highest number of marks in the first-class of each subject, under the conditions stated in the Programme of Examinations.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, December 31st and January 7th, by E. B. POULTON, M.A., on "Mimicry in Animals."

The lectures will commence at seven o'clock. Members requiring tickets are requested to make early application for the few that still remain.

As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

CANTOR LECTURES.

The fifth, and concluding lecture, of the course on "Gaseous Illuminants," was delivered by Professor VIVIAN B. LEWES on Monday evening, 22nd inst.

A vote of thanks to the Lecturer was passed, on the motion of the Chairman.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

GASEOUS ILLUMINANTS.

BY PROF. VIVIAN B. LEWES.

Lecture I.—Delivered November 24, 1890.

Although born scarcely a century ago, our gaseous illuminants have made such strides within the last ten years that I feel I need no excuse for taking them as the subject of this course of lectures, and in doing so I propose to treat more especially the new processes which are making their mark in the gas world, and, as far as the subject will allow, to omit those which are either obsolete or are gradually being superseded.

Just 200 years after Van Helmont (in the 17th century) first used the term "gas" to describe æriform bodies, Faraday defined a gas as being the vapour of a volatile liquid existing at a temperature considerably above the boiling point of the liquid, and stated that

the condensing point of the gas is merely the boiling point of the liquid producing it. This definition was at the time contested, as several of the gases had not then been condensed; but at the present time we know that the condensation of any gas to the liquid form is merely a question of sufficiently intense cold and pressure.

At ordinary temperatures, for instance, carbon dioxide, or carbonic acid gas, is as good an example of an æriform body as one could adduce, and is recognisable only from air by its physical and chemical properties, but subject the clear colourless gas to a temperature of -78.2°C . and it condenses to a clear limpid liquid which might easily be mistaken for water, and which, if the temperature is again allowed to rise to 0°C ., requires a pressure of 36 atmospheres, or 15×36 pounds on the square inch, to prevent it assuming once more the gaseous form; release it from this pressure and it at once again becomes gaseous, and in doing so absorbs so much heat that a temperature of close upon -100°C . is produced, while some of the liquid is frozen into the solid form. This shows that the state of aggregation of the body is dependent upon the existing temperature.

In the solid and liquid states, the particles or molecules of which all matter is built up, are to a certain extent checked and limited in their vibrations by the force we know as cohesion, but in the gaseous state the particles have freed themselves from this restraining force, and being able to mingle freely with other gaseous molecules, are in a condition highly favourable to the production and carrying on of chemical combination.

Gases containing hydrogen, compounds of hydrogen with carbon, and compounds of these two with other elements, have most of them so strong an affinity for the oxygen contained in our atmosphere, that the heat emitted by a burning match is generally sufficient to determine combination between the gases, and where the heat evolved by the combination is sufficient to raise the gases or vapour to incandescence, we have the phenomena of flame.

Some flames have the power, under certain conditions, of emitting light, whilst others have no photometric value, and it is a matter of the gravest import to the gas world that as clear a conception as possible should be obtained of the conditions and cause of luminosity in flame, as until this point has been definitely fixed, it is impossible to lay down the conditions under which our illuminants must

be burnt to yield their maximum lighting effect.

A visible flame may either be solid, *i.e.*, composed of a solid mass of incandescent particles, as when a mixture of nitrogen dioxide and carbon bisulphide vapour is ignited, or it may have a distinctive internal structure, and show zones in which varying phases of combustion are taking place, and it is to this latter class that all flames produced by a gas issuing from a burner belong.

A moment's consideration will at once make it manifest that if one gas is issuing in a steady continuous stream into an atmosphere containing the gas with which it is to combine, and, if combination is set up, *i.e.*, if the gas is lighted, the action can only go on for a limited space from the surface where the two gases meet, and hence such a flame must of necessity be hollow, and will contain a central zone in which entire absence of air causes absence of combustion, an intermediate zone in which partial combustion is taking place, a limited supply of air being able to penetrate; this zone is, in practically all cases, the light producing zone, whilst outside this again it is just possible to discern an envelope of non-luminous flame where the excess of air destroys all luminosity for reasons which will later be discussed. Careful examination also shows that the flame is not in contact with the rim of the burner from which the gas is issuing, this space being claimed by some observers as constituting a fourth part.

In the "Philosophical Transactions" for 1817, Sir Humphry Davy propounded his celebrated theory that the cause of luminosity in flames was the incandescence of nascent carbon, a theory which has always been accepted as the true one, until the researches of Dr. Frankland in 1868 on the effect of pressure on non-luminous flames showed that under certain circumstances, never likely to occur in a gas flame, luminosity might be due to other causes, whilst still later observers have shown that luminosity in a flame is to a great extent affected by temperature. These factors, although of the greatest importance, do not affect the truth of the original theory.

In the last contribution to the subject, Davy's theory is attacked by Mr. F. J. Rowan in a paper on "Flame," read before the Society of Chemical Industry in 1889; and, inasmuch as his paper was reprinted in full in the *Journal of Gas Lighting*, as well as in the *Journal of the Society of Chemical Industry*, and hence found its way into the hands of very many who

are interested in gas lighting in the kingdom, I think it will be of interest to fully discuss a question of such vital importance to the gas industry before passing on to other branches of the subject.

In the introduction to an article on "Some New Researches on Flame," published in the "Philosophical Magazine" in 1817, Sir Humphry Davy says, whilst alluding to a paper published in one of the early numbers of the *Journal of Science and the Arts*, "I have given an account of some new results on flame which shows that the *intensity* of the light of flames depends *principally* upon the production and ignition of solid matter in combustion," and it is round this statement that the battle of luminosity has raged, the word *principally*, however, being lost sight of, and the theory being more often propounded as "the presence of solid particles suspended in the flame (or in immediate contact with the burning gas) is *essential* to its luminosity."* An idea which Davy never had, as is shown by his later paper defining flame as follows:—"Flame is gaseous matter heated so highly as to be luminous," and again, "when in flames pure gaseous matter is burnt the light is extremely feeble." Moreover, he alludes to "common flames," evidently meaning the flames of candle, lamp, or gas, in all which cases I think it can be proved beyond a doubt that his theory as expounded by himself was perfectly correct.

On June 11, 1868, Professor G. Frankland read a communication before the Royal Society in which he describes experiments which led him to doubt Sir Humphry Davy's theory. He points out that the deposit of soot formed when a cold surface is held in a gas or candle flame is not pure carbon but contains hydrogen, which can only be got rid of by prolonged heating in an atmosphere of chlorine. Also, that many flames possessing a high degree of luminosity cannot possibly contain solid particles.

Arsenic burnt in oxygen gives a bright white light, yet as arsenic volatilizes at 180° C. and the arsenic trioxide formed at 218° C., it is evident that at the temperature of incandescence, which is at least 500° C., there can be no solids, but simply vapour, present in the flame. For the same reason the intense light due to burning phosphorus in oxygen cannot be explained by the solid particle theory. From these results Dr. Frankland

considers that "incandescent particles of carbon are not the source of light in gas and candle flames, but that the luminosity of these flames is due to radiations from dense but transparent hydrocarbon vapours." And he further shows that non-luminous flames, such as those produced by carbon monoxide and hydrogen can, when burning in an atmosphere of oxygen, be rendered luminous if the ordinary atmospheric pressure is increased to 10 atmospheres, so as to prevent or retard as far as possible expansion during combustion. From Professor Frankland's experiments there is no doubt but that the luminosity of a flame is increased by pressing around it the atmosphere in which it is burning, and also that rarefaction has the opposite effect, a point also worked out by Davy, but his experiments do not show that incandescent particles of carbon are not the principal source of luminosity in a gas flame. He also shows that the higher the density of the vapours present in a flame the more likely is it to be luminous.

In 1874, Soret attempted to demonstrate the existence of solid particles in a luminous hydrocarbon flame by focussing the sun's rays on the flame, and examining the reflected light by means of a Nicol's prism, but neither his research nor that of Burch, who repeated his experiments, using the spectroscope instead of the Nicol's prism, show more than that solid particles are present.

W. Stein ("Journal of Pract. Chem." [2] viii. 402), in considering Frankland's objections to Davy's theory, points out that the soot which is deposited from a candle or gas flame, and which Frankland looks upon as a condensed hydrocarbon, contains 99.1 per cent. of carbon, and only 0.9 per cent. of hydrogen, which is about the amount of hydrogen one would expect to be occluded by carbon formed under these conditions, and he also points out that if the soot were a heavy hydrocarbon condensed by a cold surface cooling the vapour in the flame, then it ought to again be volatile at a high temperature, which it is not.

The next steps in the controversy were the attempts made by Hilgard ("Annalen der Chemie" lxxxii. 129), Landolt ("Poggendorff's Annalen" lxxxix. 389), and Blochman ("Annalen der Chemie" clviii. 295) to trace the actions taking place in various flames by withdrawing the gases from various parts of the flame, and determining their composition, experiments which enable one to form an idea of the changes taking place in the various

* The italics in all cases are mine.—V.L.

parts of a luminous flame. Ordinary 16 to 17 candle coal-gas as supplied in London may roughly be taken as consisting of:—

Hydrogen.....	51.6
Marsh gas or methane.....	36.7
Illuminants	5.8
Carbon monoxide	5.1
Carbon dioxide	0.0
Nitrogen	0.6
Oxygen.....	0.2
	100.0

Of these, the three last only exist as traces, and play no part in the combustion, whilst of the remainder it is found that the hydrogen burns most rapidly, then the carbon monoxide, and next the marsh gas, whilst the illuminants are the slowest to burn; but when at the bottom of the flame hydrogen and carbon monoxide enter into a non-luminous combustion, forming water vapour and carbon dioxide with the oxygen of the air, they have by no means completed their function, as the aqueous vapour passing upwards through a zone of intense heat becomes again dissociated to a certain extent into hydrogen and oxygen, whilst the carbon dioxide coming into contact with incandescent carbon, liberated from the heavy hydrocarbons forming the illuminants, becomes again reduced to carbon monoxide, these only finally completely recombining to saturated products of combustion in the outer non-luminous zone of the flame. Landolt took an ordinary rich coal-gas flame, $3\frac{1}{2}$ inches in height, and traced the changes taking place by withdrawing the gases in the flame at various points from the orifice of the burner up to about two inches above it with the following results:—

COMPOSITION OF GAS IN FLAME.	HEIGHT FROM BURNER IN INCHES.					
	0	9.39	0.79	1.18	1.58	1.97
Hydrogen... ..	22.66	14.95	15.49	15.54	14.50	11.95
Marsh gas	33.77	30.20	28.34	21.55	11.92	3.64
Carbon monoxide ...	7.34	14.07	14.05	14.58	22.24	25.14
Olefines	7.29	7.49	7.87	7.94	7.05	5.45
Oxygen	0.66	0.78	0.47	...	...	...
Nitrogen	29.41	38.66	140.78	184.23	270.45	307.10
Carbon dioxide ...	1.94	2.34	10.11	14.98	23.76	32.34
Water	8.34	11.60	38.85	52.55	72.67	75.61

He used a gas containing a high per-centage of illuminants, and on examining his results we see that the hydrogen is the first to burn, as

one would expect from its relatively low igniting point and great rapidity of combustion. The burning of the carbon monoxide cannot be traced in the same way, as it is formed more rapidly by the incomplete combustion of the marsh gas that it burns, so that a steady increase in the proportion takes place, whilst the marsh gas steadily burns away until a height of $1\frac{1}{2}$ inches is attained, when its combustion becomes very rapid.

The illuminants practically undergo no change at first, indeed they slightly increase in quantity from the decomposition by heat of some of the marsh gas into acetylene; and they only begin to decompose at a height of $1\frac{1}{2}$ inches above the orifice of the burner, and then burn rapidly in the highest part of the flame.

A most important fact, moreover, to be noted is that at the height of $1\frac{1}{2}$ inches there is a sudden rise in the quantity of carbon monoxide at the moment that the illuminating olefines begin to disappear, a result undoubtedly due to the action of the nascent ignited carbon on carbon dioxide.

Amongst the illuminants are several hydrocarbons, the probable composition of which will be discussed in the next lecture, and these are gradually broken down in intermediate stages in the lower part of the flame, until finally they become marsh gas and carbon, and it is this carbon which in excessively minute particles at the moment of liberation is heated to incandescence, and "principally" gives the light of the flame. The marsh gas originally present and also that formed from the heavier hydrocarbons adds its iota to the luminosity by still further decomposition during combustion, before finally being carbon dioxide and water.

In 1876, Dr. Karl Heumann made most important contributions to the theory of luminous flames in some papers published in "*Liebig's Annalen*," vols. clxxxi. and clxxxii., in which he carefully goes over the work of previous observers, and by a large number of original experiments proves that Davy's theory was correct, but that other causes also affected the degree of luminosity in a gas or candle flame.

In the ordinary atmospheric burner in which a mixture of coal-gas and air burns with a non-luminous flame, it was supposed that the admixture of air supplying oxygen to the inner portion of the flame caused immediate and complete oxidation of the hydrocarbons without giving time for the liberation of carbon in the flame and consequent luminosity.

More modern researches, however, have

proved this to be utterly wrong, the loss of luminosity being due to two causes :—

1. The diluting action of the air introduced.
2. The fact that when a gas is so diluted it requires a far higher temperature to break up the hydrocarbons present than when the gas is undiluted; and, therefore, the temperature which serves to liberate carbon, and render the undiluted gas flame luminous, is totally insufficient to do so in the diluted gas, and in consequence the hydrocarbon burns to carbon dioxide and water, without any such liberation, and hence with a non-luminous flame.

The truth of this theory can be easily proved by the fact that diluting the gas with nitrogen, carbon dioxide, or even steam, serves to render it non-luminous, and, therefore, more rapid oxidation has very little or nothing to do with it, whilst the non-luminous flame can again be rendered luminous, either by heating the mixture of air and gas just before combustion, or by heating the air with which the gas is diluted.

This being so, it is evident that in the non-luminous flame we have the same hydrocarbons present as in the luminous flame, and anything which will tend to break them up and liberate the carbon before the hydrocarbons are consumed, should again make the flame luminous. That heat will do this has been already shown, but it can be demonstrated in a still more striking way. It is well known that chlorine gas and bromine vapour will both support the combustion of a gas containing much hydrogen, but that the combustion is very different from that of the same gas burning in air, as the chlorine or bromine having no affinity for the carbon, combines with the hydrogen only, and deposits the carbon in clouds of soot. In other words, at the temperature of flame chlorine will break up the hydrocarbons and liberate solid carbon. If now a small quantity of chlorine be led into the non-luminous Bunsen flame, it at once becomes luminous, proving conclusively that luminosity is due to solid particles of carbon liberated in the flame.

Again, Heumann points out that a small rod held in the luminous flame becomes rapidly covered on its lower side with a deposit of soot, *i.e.*, the soot is present in particles in the flame, and the uprush of the gas drives it against the rod, and deposits it there. If the soot were present in the flame, as Frankland supposes, in the state of vapour, and the rod merely acted by cooling and condensing it, then the soot should be deposited on all sides

of the rod, whilst a still further proof is that if the soot existed as vapour in the flame, then if the rod were heated to a high temperature, no soot should be deposited on it, whereas the soot deposits on a heated surface just as well as on a cool one.

It has been objected to the solid particle theory that if it were true, then solid carbon particles introduced into a non-luminous flame should render it luminous, and make it look like an ordinary gas flame, whereas it simply gives rise to a cloud of sparks. But it must be remembered that the "nascent" carbon, as it is liberated from the decomposing hydrocarbons, is in the molecular condition, and has a very different degree of coarse-grainedness to any preparation of charcoal or lamp-black we can make, and that although our finest particle is a mass which takes so long to burn that it leaves the flame only partly consumed, and is projected into the air as a spark, yet the molecular particles of carbon are consumed as soon as they are rendered incandescent, and a steady luminosity free from sparks results.

It is possible, however, to make the particles in a luminous flame roll themselves together, when they can be either deposited in a very coarse kind of soot or be seen as glowing sparks and particles in the mantle of the flame. This can be done when two luminous flames are allowed to rush against each other or against a heated surface.

Heumann also shows that the luminous mantle of a flame is not altogether transparent, and that the thicker the flame-layer and the greater the number of solid particles contained in it, the less transparent does it become. If a non-luminous hydrogen flame is charged with the vapour of chromyl-dichloride (CrO_2Cl_2), chromic oxide is produced, and this flame, undoubtedly containing solid particles, is quite as transparent as the hydrocarbon flame; whilst, finally, those flames which undoubtedly owe their luminosity to the presence of finely divided solid matter, produce characteristic shadows when viewed in sunlight; the only luminous flames which do not throw shadows being those which consist of glowing vapours and gases. Luminous gas-flame, oil lamp-flame, and candle-flames produce strongly marked shadows in sunlight, and therefore contain finely divided solid matter, and that this can be nothing but carbon is evident from the fact that all other substances capable of remaining solid at the temperature of these flames are absent.

From these considerations it seems to me

that Sir Humphry Davy's statement, "that the intensity of the light of flames (such as candle, oil, or gas) depends principally upon the production and ignition of solid matter in combustion," is undoubtedly the true one, and we must also bear in mind that the degree of luminosity of a flame is affected by the constituents of the gas other than heavy hydrocarbons; some, like marsh gas, although ordinarily burning with an apparently non-luminous flame and separating no soot, yet add considerably to the luminosity at the temperature of the flame, whilst others like carbon monoxide reduce it. This question, which I hope to discuss in the next lecture, has most important bearings upon the illuminating values of the newer forms of gaseous illuminants; and finally, in considering the amount of light obtainable from a flame, we must not lose sight of the question of temperature, which will be best brought to your notice when speaking of the newer forms of burners employed in the combustion of coal-gas.

The luminosity of a flame is increased by increase of density in the media in which it is burning, and decreased by rarefaction, facts made strikingly clear by Frankland's experiments, although noted as early as 1658 by Boyle. The effect was supposed by Frankland to be due to the alteration of the mobility of the oxygen molecules in the air with the alteration in density; this view, however, is contested by Wartha, who concludes that it is due to the effect of pressure on the dissociation point of the hydrocarbons burning in the flame, this taking place more rapidly under an increased pressure, and the carbon being therefore more quickly liberated. Be this as it may, the effect of pressure on luminous flames is very marked even under ordinary atmospheric pressure, the difference of an inch in the barometric column making 5 per cent. difference in the luminosity, *i.e.*, a burner giving 100 units of light with the barometer at 30 in. would only give 95 if it fell to 29, whilst a rise to 31 in. would mean an increase of the luminosity to 105 units.

Miscellaneous.

MINING IN WESTERN AUSTRALIA.

Western Australia, with an area of 1,060,000 square miles, nine times that of the united British Isles, has a population of only 42,000. In this it

affords a great contrast to Victoria, which, with only 88,000 square miles, is peopled by 1,090,000. A large part of the area is still unexplored, and the settled portions are confined to, roughly, some 200 miles inland around the coast. Information respecting the mining prospects of the interior are necessarily very vague, as it has been crossed only on a few routes by exploring parties, but for the settled parts there has been this year issued the first two Annual General Reports for 1888 and 1889,* by the Government Geologist, Mr. H. Page Woodward, which give such details respecting mining as he has been able to collect. In 1888 he "travelled about 8,100 miles, and roughly mapped 67,500 square miles of country," and in 1889 about 4,000 miles, mapping some 64,000 square miles. The information he gives on mining is partly compiled and partly based on his own observations; and it is intermingled with the geographical and geological notes in the nine reports of his journeys, which, together, make the general report. In an appendix he prepared for the catalogue of Western Australian exhibits at the recent Mining Exhibition, much of this information was reproduced in a more connected form. So far as dates are given, it appears that the earliest mines worked were those of lead and copper, of the Champion Bay district, in 1840. In 1847 the Irwin Coal-field was discovered; and in 1868 alluvial gold was found. All the workings were carried on but for a short time. The discovery of reef gold appears to have been everywhere later than 1884. "In many places in this colony," Mr. Woodward writes, "settlers have been living for nearly fifty years with rich mineral deposits under their very feet; but, it must be remembered, that these early settlers had little knowledge of anything but farming; that they were only a handful of people, and that the struggle for existence was terrible." The minerals, which are named as known to exist though they are not all worked, are gold, copper, lead, tin, coal, iron, antimony, zinc, manganese, mica, asbestos, graphite, and kaolin. "Until quite recently, this colony was considered to be destitute of mineral deposits of any value, with the sole exception of the rich deposits of lead and copper in the Northampton district. . . . Now it is known it is a rich mineral-bearing country from north to south, and every day news of fresh discoveries of gold and other valuable metals is coming in" (p. 21). Among the drawbacks to taking advantage of the discoveries, the chief mentioned are want of capital and the construction put on the mining regulations, which has been too lenient. Both are spoken of as not likely to exist long. Want of water in some districts, and flooding of mines in others, have had retarding effects on mining enterprise. The hundreds of miles of bush travelling to risk mining on but vague rumours, is gradually

* Western Australia. Annual General Report for 1888-89, by Harry Page Woodward, F.G.S., F.R.G.S., Government Geologist, Perth. By authority, Richard Pether, Government printer, 1890.

being replaced by the conveniences of the railroad and the reports of skilled inspection. The Geologist mentions that he hopes to have a geological map of the whole colony ready by the end of this year; the portions that are settled will be from personal examinations, but for the vast interior he will be "only able to fill in such information as can be gained from reports and maps of explorers." Speaking of iron, he says that it occurs mostly as black and red oxides, that there is "enough to supply the whole world," and that its abundance makes it almost impossible to work with any degree of accuracy with a magnetic compass. The gold fields of the Yilgarn Hills (about 200 miles east of Perth), are spoken of as presenting "one of the finest surface indications yet met in Australia." With so few inhabitants the amount of actual "prospecting" done is comparatively small, but it is mentioned that what is at present discovered is more than can be worked. "What now is needed is the incoming of an enterprising people with money. . . . There are not sufficient people here with money to work more than one or two mines efficiently, while at the present time they are trying to work a hundred, and as a natural consequence failures are occurring on every side" (p. 27).

The records of the mining that has been accomplished embrace only gold, lead, copper, tin and coal. Good lodes of antimony and manganese have been found, but are not worked yet. Zinc has in one place assayed 75 per cent. The mica obtained so far is iron stained, and will need deep working to reach it clear. The graphite, though of very fair quality, is far from a port, but now that a railway passes near it may pay to work. The kaolin of the Darling range is pure enough to be used as white-wash, and the "deposits will be of great value for china making when the population increases."

Of coal, there are three kinds—(1) true carboniferous, in the Irwin district, where there are seven seams, varying from three to eight feet in thickness, and which can be traced for distances of forty miles north and south, but it is not so good as the New South Wales coal; (2) mesozoic coal, on the Collie river, good enough for smelting purposes in the neighbouring tin-fields; (3) and mesozoic lignite, similar to that used in America for steam and other purposes. At Wyndham, in Cambridge Gulf (the nearest port to India), coal has been found, which raises the hope that it may make the locality an important coaling station.

The Green Bushes tin-field spreads over at least fifty square miles. Since the discovery, in 1888, it has been somewhat worked, and a good rainfall, and the existence there of one of the best roads in the colony, are conditions favourable for mining development.

The copper and lead lodes that have been worked, are in the Champion Bay district and Irwin district. In the Champion Bay district there are nine mines mentioned. Many of the mines were abandoned

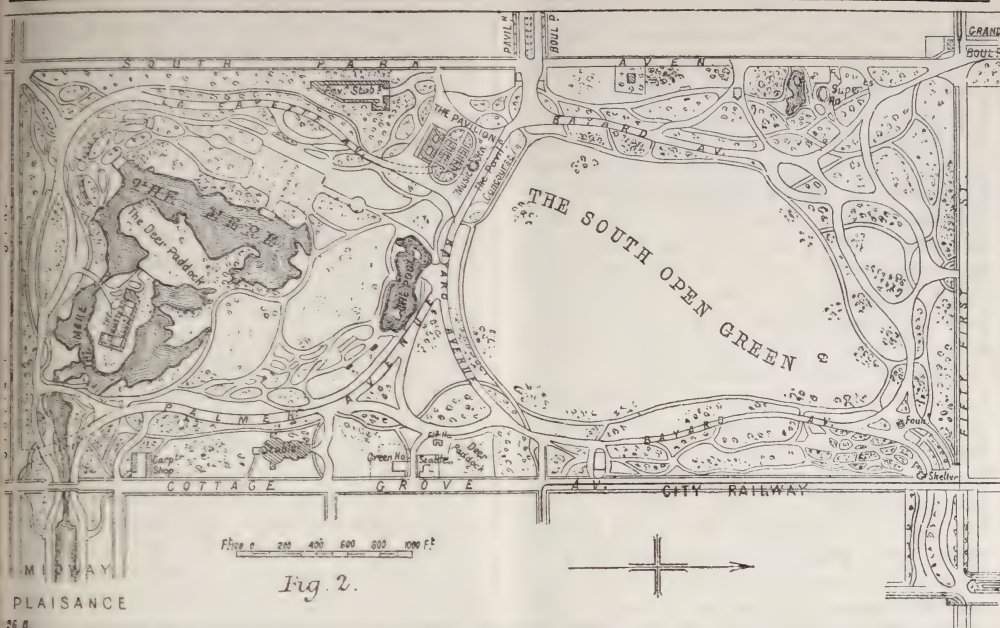
when the market prices fell, but the Government has offered a subsidy of £10,000 for the first 10,000 tons of lead melted in the district. There is suitable coal within forty miles of the Geraldton mines, and a direct line of steamers runs from Geraldton to Singapore, through which the Chinese markets, when there is a demand, could be reached.

Gold has been worked, and worked with success, in many places. The principal "fields" are the Kimberley in the north-east, the Pilbarra in the north-west, and the Yilgarn in the south-west. The largest area is that of Kimberley, given as 47,000 square miles, but this is the least worked. It is far away from the more settled districts, and people appear to be afraid to expend their energies in going there, as the experience is "we find two bogus mines for every genuine one" (p. 23). The Pilbarra fields extend over 32,000 square miles, and this district is spoken of as "one of the most promising mineral areas in the colony." From a reef on the Mallina claim, ten feet wide, good crushings were obtained. From a narrower reef, about five miles off, the returns were ten ounces to the ton. From reef and alluvial together "large quantities of gold have been sent away from this district." No returns in figures are presumably obtainable as none are given. The smallest field, Yilgarn, 13,000 square miles, is that which has been most worked. Many companies are at work in the different divisions of the field. In the Golden Valley division there are four mines, in the Southern cross seven, and in the Parker's range three. A considerable amount of machinery has been introduced, and though this has been done very recently all the results seem to be satisfactory.

Throughout the reports there are hardly any statistics given, for the development of the mining industry is so young there is not as yet a department of mines for collecting them. Almost every page, however, speaks of the richness of mineral wealth that waits to be worked.

CHICAGO EXHIBITION, 1893.

By the courtesy of the proprietors of *Engineering* the two maps, showing the proposed arrangements for the Exhibition buildings, which were published last week in that newspaper, are now printed in the *Journal*. Fig. 1 shows the Jackson-park site, on the shore of Lake Michigan; Fig. 2, the Washington-park site; the two being connected, as readers of Mr. Dredge's recent paper will remember, by the Midway Pleasance. It has been decided that the principal buildings are to be in Jackson-park. Only about one-third of this land has been completely reclaimed; much of it is still covered with small timber and undergrowth, and it is broken up by lagoons connected with the lake. A good deal of work, therefore, will have to be done on the ground itself; but it appears to be of a character which will readily lend itself to the treatment of the landscape



CHICAGO EXHIBITION (WASHINGTON-PARK SITE).

TOBACCO CULTURE AT VERA CRUZ.

The British Consul at Vera Cruz has recently furnished a report on the cultivation and manufacture of tobacco in that State. It seems from his report that Vera Cruz annually raises about 5,000 tons of tobacco, and exports about 700 tons. England is the most extensive purchaser, taking £96,000 worth of manufactured and £5,000 worth of raw tobacco, making a total of £101,000 out of a grand total of £140,000.

To prepare the ground for tobacco cultivation, it is of course first cleared, and the underwood, stubble, and weeds burnt, the ashes being spread over the ground as manure. As a rule this is the only manure used, though some planters recommend guano. Potash is too strong, and is never used. The land is ploughed and harrowed in a somewhat primitive fashion, and is then ready for planting. A tobacco plantation is sometimes expected to raise each year, or eight years running (when it gets one year of allow), not only two crops of tobacco, but one of maize, and one of black beans also, in all four crops per annum. The tobacco is of course always the principal crop. It is planted in September, and the first crop cut in November, when the maize is planted between the tobacco plants. The maize is cut in March, by which time the second crop of tobacco has also been cut, and so the land is free for the black beans, which in their turn are cut in August, and after that the land is again prepared for tobacco. It is only a climate like that of Vera Cruz that will thus raise four crops a year on the same land with only such manure as it produces itself, namely, the ashes of the stubble and weeds. The custom, however, of raising maize and black beans

with tobacco is dying out, as it is found to be detrimental to the tobacco. The experiment has been made of planting tobacco in May, but without success; the summer sun is too hot, and the leaves droop and fade.

The seed beds are about 10 yards by 10 yards to 50 yards by 50 yards square, and these beds are sown at intervals of 14 days, so that the plants may not all require similar attention at the same time. The most advanced planters consider it false economy to restrict the size of the seed beds, as over-crowded seedlings do not thrive well. The seed bed, if not kept moist by rain, is well watered, and it is also well furnished with little ditches to carry off the storm water which might otherwise wash away the young plants. This done, the seed is sown broadcast, or, rather, it is put into a basket which is shaken gently over the bed in broad lines; scattering the seed by hand leads to great inequalities in distribution, especially if there be any wind. In about a week the seed bed presents the appearance of a green carpet. To protect the seedlings from the sun, a rough awning of matting is sometimes put up, about a yard and a half from the ground.

No sooner have the young leaves of the plant attained the size of a shilling, than they are attacked by the *losquilla*, a small caterpillar that makes its appearance at night, and it is at night that this little enemy of the planter has to be encountered and killed, otherwise it eats the stalk of the plant just above the ground, and the plant then falls and dies. The seedlings are transplanted when the leaves are about the size of a five-shilling piece; they are planted in rows about 40 inches apart. If no other crops are raised, the plants are allowed 16½ inches

between each other, but if other crops are grown, the tobacco seedlings are planted at a distance of 33 inches apart. In a week from the transplanting the plants that have failed to take root are removed, and replaced by others from the same seed bed, so as to insure rapid growth. About a fortnight after transplanting the heart of the plant is attacked by a second grub, who has to be hunted and killed in the early morning. This insect is known as the *logollero*; the eggs are laid in the heart of the plant, and when the egg is hatched the grub proceeds to eat the young leaves and fasten them together, so as to form himself a little living room and larder combined.

When the plant has attained the height of about a yard, the top bud is nipped off to prevent the upward growth, and to promote the development of the leaves, and about this time a third grub appears, known as the *primavera*, which, if left undisturbed, will eat an entire leaf per day, reducing it to a perfect skeleton. The caterpillar of the *primavera* attains the length of four inches when fully grown. In about three months after sowing the plant begins to emit an aroma, and its leaves assume a yellow colour and their points become dry, which is a signal for cutting. The old custom was not to cut the leaves but the plant itself, about two inches from the ground, the root being left to produce the second crop, which is always of smaller leaves. The new system is to cut each pair of leaves off, together with so much of the stalk as is necessary to keep them together. They are then put astride on a pole about four yards long, and are thus carried to the drying-house, where the ends of the poles are on cross beams in such a way as to leave drying space for each pole of leaves. The leaves are kept in the drying-house for about four days, and then exposed to the sun for five days, after which they are returned to the drying-house for fourteen days. Where the old system prevails, the cut plants are piled in heaps with their stalks towards the sun so as to expose the leaves as little as possible to its rays. Then they are hung up to dry, the large plants separately, the smaller ones in pairs. The drying-shed is a very primitive affair, consisting of a thatch or matting roof supported on poles. After hanging from twenty to twenty-eight days, according to the weather, the plants are fit to undergo the first fermentation. A cloudy, damp morning is the best for handling the leaves, as on a dry day they are apt to crack, and thus reduce their value. To bring about the fermentation the leaves or plants, as the case may be, are piled in a heap three yards high by nine yards in circumference, and containing about 120 to 125 arrobas (25 lbs. to the arroba). In a week the pile begins to ferment, and in a fortnight the fermentation is complete. The leaves are next tied into bundles called *gavillas*. The number of leaves in a *gavilla* depends on the size and quantity of the leaves, which are divided into four classes, the first three classes being used for the covers of cigars, and the fourth quality for fillers. But this classifica-

tion rules only on the plantation. In the factory the leaves are divided into more than a dozen classes. The filling leaves are those that are either cracked, perforated, or ill-looking. The *gavillas*, when cured at all, are cured in the following manner. They are strewn on the floor and sprinkled with a preparation made by infusing about 25 pounds of tobacco stalks in a barrel of water, to which is added about a bottle of *aguardiente* (a spirit distilled from sugarcane), or of wine. After this sprinkling the *gavillas* are made into a square heap, with the stalks outside, and they remain in the heap several days, during which they undergo the second and last fermentation. If, as is generally the case, the tobacco is not manufactured on the plantation, it is now packed for transport. The bales are generally packed in *calzon de jagua*, a kind of natural cloth that grows on the palm trees (probably the spathe of a palm), but common qualities of tobacco are often packed in *petates* (rough rush mats). Any substance that is at all waterproof is unsuitable, as impeding ventilation and thus causing fermentation, while substances that are too open allow the tobacco to dry and deteriorate.

The cost of labour on the plantation is not heavy. An unskilled labourer, such as a grub picker, gets 4r. or 1s. 6d. per day or night, as the case may be, whilst the foremen or gangers get 6r. per day each. The principal cigar manufactories are in the town of Vera Cruz, where one maker alone exports £50,000 worth of cigars per annum to England. One pound of wrappers, and 2 lbs. of fillers will make 200 cigars of 13 lbs. to the 1,000. One workman can make 200 cigars of medium quality, as regards make, in one day, and 50 to 100 of the highest class. The workmen are paid by the piece, the prices ranging from about 2s. 9d. to 13s. 4d. per 100. A good workman, making 200 cigars of medium quality, will receive 10s. 6d. for his day's work, and a first-class maker will often earn, at finest work, 18s. a day.

As regards prices, there is always a large margin between the lowest and the highest prices for precisely the same article. For instance, good *capa*, or wrappers, can sometimes be bought for 7d. per lb. of small planters. The buyer sorts the leaves into first and second class, and at once raises his price to 1s. 6d. first class, and 1s. 2d. second class, namely, more than double the original cost; with *tripa*, or fillers, too, there is a similar manipulation, though the dealers' profit is not so great. But the highest qualities of tobacco fetch high prices, even on the plantation, and as much as 10s. 6d. has been obtained per 100 leaves, which would probably be equal to 5s. per lb. Planters often carry on their business with very little capital, and have to mortgage or sell their crops whilst it is growing, conceding to the mortgagee or buyer, as the case may be, large interest or profits to cover the risk of the crop being lost. But planters with sufficient capital make on an average of seasons very large profits, especially those who combine cigar-making with planting.

The prices of the cigars range from £3 9s. per

1,000 to £17 10s. per 1,000, weighing about 20lbs. per 1,000. The price of a cigar often depends more on the quality of the make than of the tobacco, the reason being that skilled labour is dear, especially in the town, where living is very expensive. In the country one can often buy cigars at 10 dols., or £1 10s. per 1,000, though of course the quality of tobacco and make is very inferior. Still such cigars have in times past been bought up by unprincipled dealers, and exported as "Conchas finas," at 20dols. per 1,000. Happily, such practices are now very rare, as most foreign buyers now prefer the brands of well-known houses of repute, even if dearer, to the cheap bargains offered by dealers who collect cigars from small makers, buying from hand to mouth, and thus obliged to be content with the leavings of buyers having the command of capital.

The cigar which is principally exported at Vera Cruz for England is the "Concha fina," weighing from 13lbs. to 14lbs. per 1,000, the local price of which is 23 dols., or £3 9s. per 1,000. The making of this cigar costs about 50 per cent. of its wholesale price, and that is no doubt the reason why Germany takes so little manufactured tobacco (about £2,500 per annum), whilst of leaf tobacco she takes as much as £12,500 a year.

Of the enormous quantity of tobacco grown in this district (about 500 tons per annum), a large proportion is equal to the best Havana, though not of precisely the same flavour, and a still greater quantity falls in quality through the maltreatment it receives on the plantation, in transit, and in the second-class factories. Another difficulty Vera Cruz tobacco has to contend against in the foreign markets is caused by the little care bestowed on the sorting of the leaves, and the consequent inequality in the colour and appearance of cigars supposed to be of the same brand. But this defect is being remedied by some makers, who have taken to grow their own tobacco, and to spend more pains on the sorting and treatment of the leaves, so that they manage to produce brands that maintain their reputation not only for quality of tobacco and make, but also for colour, flavour, and form.

There can be no doubt that the present export of tobacco—about £14,000 per annum—is only a preliminary to a very extensive foreign trade in that article, and that Vera Cruz will soon be a serious rival to Havana, and especially will this be the case when consumers learn the fact that moderate-priced Vera Cruz cigars are much superior to moderate-priced Havanas. It has hitherto been thought, but wrongly, that it is only the lowest-priced Vera Cruz cigar that is cheap. As a matter of fact, the moderate-priced Vera Cruz cigars are cheaper than the low-priced, having regard to quality and value, and as to the high-priced, Vera Cruz cigar experts have been known to prefer them to higher-priced Havannas, under conditions which made it impossible to tell the different brands except by taste. Such an experiment may not prove the market value of a cigar,

which, like wine, depends so much on fashion, but it is a good test of quality, which is the present question.

The district of Vera Cruz, with its climate and soil so suitable to the tobacco plant, presents a wide field for the employment of British capital in tobacco planting, especially if the capitalists allied himself with local cigar manufacturers, who are always ready to buy or make up leaves of equal size, colour, and quality, conditions which can only be obtained by a regular system of planting, sowing, curing, and sorting. Buying raw tobacco in the open market is a lottery, and leads to the present unevenness in the colour and flavour of the Vera Cruz cigar, which is found in so many otherwise good brands.

THE MAHOGANY TRADE OF HONDURAS.

The Republic of Honduras, as well as the territory known as British Honduras, have long been celebrated for their forests of mahogany and other fine-grained woods. Belize, the capital of the British possessions in Central America, now a city of considerable commercial importance, owes, says the United States Consul at Ruatan, its origin and wealth to the mahogany cutters. During the first half of the present century princely fortunes were quickly accumulated in the business, but since iron and steel have taken the place of wood in the construction of vessels, the mahogany trade has decreased to a notable extent, although it is still large and profitable. The mahogany cuttings of British Honduras require at present more capital to carry them on than formerly. The expense and difficulty of getting out the wood has greatly increased, as but comparatively few trees can now be found near to the banks of rivers and streams of sufficient depth of water to float the logs to the coast. In Spanish Honduras, and especially within the limits of the consular district of Ruatan, there are still forests abounding in mahogany and other precious woods, where foreign industry and capital might be safely and profitably employed. The following is the system employed in manipulating the mahogany and in felling the trees, and in hewing, hauling, rafting, and embarking the logs in Honduras. Having selected and secured a suitable locality, and arranged with one of the exporting houses of Belize to advance the means in provisions and money to carry on the works, the mahogany cutter hires his gang of labourers for the season. Nearly all labour contracts are made during the Christmas holidays, as the gangs from the mahogany works all congregate in Belize at that period. The men are hired for a year, at wages varying from twelve to twenty dollars a month. They generally receive six months' wages in advance, one half of which is paid in goods from the house which furnishes the capital. The cash received by the labourers is mostly wasted in dissipation before they leave the city. Early in January the works are commenced. Camps, or

"banks" as they are called, are organised at convenient places on the margin of some river in the district to be worked. Temporary houses, thatched with palm leaves, are erected for the labourers, and a substantial building for the store and dwelling of the overseer. The workmen are divided into gangs, and a captain appointed over each gang, whose principal duty is to give each man his daily task, and see that the same is properly done. All work in mahogany cutting is done by tasks. The best labourers are out at daybreak, and generally finish their task before 11 o'clock. The rest of the day can be spent in fishing, hunting, collecting india-rubber and sarsaparilla, or in working up mahogany into dories, paddles, bowls, &c., for all of which a ready market is found. The mahogany tree hunter is the best paid and the most important labourer in the service. Upon his skill and activity largely depends the success of the season. Mahogany trees do not grow in clumps and clusters, but are scattered promiscuously through the forests, and hidden in a dense growth of underbrush, vines, and creepers. It requires a skilful and experienced woodsman to find them. No one can make any progress in a tropical forest without the aid of a *macheté*, or heavy bush knife. He has to cut his way step by step. The mahogany is one of the largest and tallest of trees. The hunter seeks the highest ground, climbs to the top of the highest tree, and surveys the surrounding country. His practised eye detects the mahogany by its peculiar foliage; he counts the trees within the scope of his vision, notes directions and distances, then descends and cuts a narrow trail to each tree, which he carefully marks, especially if there is a rival hunter in the vicinity. The axemen follow the hunter, and after them go the sawyers and hewers. To fell a mahogany tree is one day's task for two men. On account of the wide spurs which project from the trunk at its base, scaffolds have to be erected and the tree cut off above the spurs, which leaves a stump from 10 to 15 feet high. While the work of felling and hewing is in progress, other gangs are employed in making roads and bridges, over which the logs are to be hauled to the river. One wide truck pass, as it is called, is made through the centre of the district occupied by the works, and branch roads are opened from the main avenue to each tree. The trucks employed are clumsy and antiquated contrivances; the wheels are of solid wood, made by sawing off the end of a log and fitting iron boxes in the centre. The oxen which draw these trucks are fed on the leaves and twigs of the bread-nut tree, which gives them more strength and power of endurance than any other obtainable food. Mahogany trees give each from two to five logs, 10 to 18 feet long, and from 20 to 44 inches in diameter after being hewed. The trucking is done in the dry season, and the logs collected on the bank of the river, and made ready for the floods which occur on the largest rivers in June and July, and on all in October and November. The

logs are turned adrift loose and caught by booms. Indians and Caribs follow the logs down the river to release those which are caught by fallen trees or other obstacles in the river. The manufacturing process consists in sawing off the log ends which have been bruised and splintered by rocks in the transit down the river, and in re-lining and re-hewing the logs by skilful workmen, who give them a smooth and even surface. The logs are then measured, rolled back into the water at the mouth of the river, and made into rafts to be taken to the vessel, which is anchored outside the bar. The building of sloops and small schooners for the coasting trade is an important industry in the island. The frames of such vessels are made of mahogany, Santa Maria, and other native woods of well-tested durability, and proof against the ravages of worms which abound in the waters. At present the only woods exported from Honduras are mahogany and cedar wood, although the forests abound in other varieties, which Consul Burchard states are quite as useful and ornamental, and which must eventually become known in foreign markets, and open "New and inviting fields for industry and trade."

Notes on Books.

LABORATORY WORK. By A. G. Earl, M.A.
London: Longmans. 1890.

This is a practical introduction to the study of physics. A number of experiments are described—in more or less detail—and the conclusions to be drawn from them pointed out. Mr. Earl commences with the "Measurement of quantity of matter," and in this first chapter he takes the student from the simplest possible experiment, the counterpoising two pieces of wood, equalising them by cutting, to the use of the vernier, the micrometer screw, and the spherometer. A chapter on "Observations on changes in position," commences with a description of the usual means of defining position by means of rectilinear co-ordinates and ends, with an elementary machine—the conversion of circular into rectilinear motion. Chapters follow on temperature, statics, electricity, and chemistry, all treated as changes in the condition of matter, and all as a continuous line of experimental investigation, which the student is expected to follow, and from which he is taught to draw certain conclusions.

General Notes.

ROYAL COLLEGE OF SCIENCE.—Dr. C. Le Neve Foster, Inspector of Mines under the Home-office, son of the late Mr. Peter Le Neve Foster, Secretary to the Society of Arts, has been appointed by the Lord President of the Council, Professor of Mining in the Royal College of Science, London, with which the Royal School of Mines is incorporated.

Journal of the Society of Arts.

No. 1,989. VOL. XXXIX.

FRIDAY, JANUARY 2, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

Mr. E. B. PAULTON, M.A., gave the first of his course of Juvenile Lectures on Wednesday evening, 31st ult., the subject being "Mimicry in Animals." The lecturer described the various uses of colour in animals, and illustrated his remarks by throwing upon the screen, by means of the lantern, a large number of coloured figures of a variety of animals, such as spiders, birds, fish, caterpillars, moths, crabs, &c.

The first group illustrated the use of colour for the purposes of giving pleasure, and of attracting the attention of other animals of the same species. Here, whatever colour might be on the body of the animal was prominently displayed, and when there was no colour on the body, the animal would gather together beautiful objects to attract, as was the case with the bower bird.

The next group contained numerous instances of the use of colour for protection and aggression. In the case of protection, the various animals assimilated in appearance to the branches of trees, leaves, and other objects, and in some instances the animals were shown first alone, and then in their natural habitats, when it was most difficult to find them; thus the pipe-fish could not be distinguished when swimming among the sea-grass. Another remarkable instance was that of a certain spider, which resembled a dead object, and, to carry out the illusion, spun an uneven and ragged-looking web. Another branch of the protective colours contained those used for warning. Certain animals were known to be disgusting, as the skunk; dangerous, as wasps

and serpents; and others were disagreeable to the taste. Here the object was to make their colour specially marked, so that other animals might not mistake them for more agreeable prey. Some animals, to escape destruction, imitated these; thus, a certain caterpillar, instead of being lost sight of by its likeness to the branch of a tree, would appear like a small snake. The hermit crab, which was apt to fall an easy prey to the ravenous fish, saved itself by making sea anemones (which sting) fix themselves on the shell in which he seeks shelter.

The last group was that of the animals whose only hope of protection is found in congregation, and these are marked by a white spot on their back or tails. This was illustrated by an assembly of rabbits, the white of whose tails helps to point out the means of escape to those who follow them. Without some such aid, the solitary rabbit is apt to lose his way.

Mr. PAULTON will deliver the second lecture of the course, which will be devoted more particularly to Mimicry, on Wednesday next, the 7th inst., at seven o'clock.

EXAMINATION PRIZES.

The Council of the Society have determined to offer the following prizes, in connection with the Society's Examinations for the year 1891, out of the funds which have been placed at their disposal for the purpose by the Worshipful Companies of Goldsmiths, Mercers, Salters, and Skinners:—A first prize of £3, and a second prize of £2, in each of the following subjects: English, Commercial Geography, French, German, and Portuguese.

The prizes will only be awarded to candidates who have taken first-class certificates, and are certified as proficient by the examiner in each subject.

In addition to the above prizes, the Clothworkers' Company offer first, second, and third prizes, of £5, £3, and £2 respectively, to candidates obtaining a first-class certificate in Italian or in Spanish.

The above prizes are additional to the Bronze Medals, which will be awarded to the candidates obtaining the highest number of marks in the first-class of each subject, under the conditions stated in the Programme of Examinations.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

GASEOUS ILLUMINANTS.

BY PROF. VIVIAN B. LEWES.

Lecture II.—Delivered December 1, 1890.

Having collected the known facts bearing upon the cause of luminosity of flames burning under ordinary atmospheric conditions, and having seen that such luminosity is governed by the separation of nascent carbon due to the decomposition by the heat of the flame of heavy hydrocarbons present in the gas, it is evident that anything which affects the quantity of hydrocarbons present, the ease with which they decompose or the temperature of the flame must also affect the luminosity, whilst a great deal will also depend upon the characteristic properties of the portions of the gas which act as carriers of the illuminating compounds. In the various analyses of illuminating gases, the heavy hydrocarbons are as a rule expressed as "illuminants," and used to be considered to consist mainly of ethylene, an idea which the researches of the last few years have shown to be totally erroneous. Besides ethylene there are undoubtedly present benzene, propylene, butylene, and acetylene, and also such members of the paraffin series as ethane, propane, and butane, whilst, under certain circumstances, crotonylene, terene, allylene, and others are present, so that the determination of the illuminants is by no means the simple process one would

imagine it to be from the directions given in most text-books on gas analysis.

The illuminants present in any given sample of coal gas depend upon (1) the kind of coal used, (2) the temperature at which the coal is distilled, and (3) the length of time during which the gas is in contact with the heated sides of the retort, and also the time during which it is in contact with the liquid products of the distillation.

1. The kind of coal used.

In an important paper read before the Society of Chemical Industry in January, 1885, Mr. G. E. Davis describes experiments on the hydrocarbons in ordinary and cannel gas, in which he passed large volumes of the gases through olive oil. This oil has the power of absorbing any hydrocarbon vapours of compounds liquid at ordinary temperatures, which are being borne along as vapour by the carrying power of the hydrogen present in the gas. He found that illuminating gas from 17 to 19 candle power was reduced to 8, and that, on recovering the hydrocarbons from the absorbent, a very small fraction, not exceeding 2 per cent., had a boiling point below 80° C.; whilst with cannel gas, having an illuminating power of 27 candles, on passing through the olive oil the candle-power fell to 19. The hydrocarbons, on being separated, proved to be very different, 29.9 per cent. boiling below 80° C.; whilst 12 per cent. had a boiling point below 23° C., and probably consisted of crotonylene.

2. The temperature at which the coal is distilled.

As the temperature is increased, the yield of gas from a given weight of coal also increases, but with the increase of volume there is a marked decrease in the illuminating value of the gas evolved. Mr. Lewis T. Wright, in a series of experiments (*Journal of the Chemical Society*, 1884, p. 99), found that when four portions of the same coal were distilled at temperatures ranging from a dull red heat to the highest temperature attainable in an iron retort, that he got the following results as to yield and illuminating power:—

Temperature.	Gas per ton.	Illuminating power.	Total candles per ton.
I. Dull red	8,250	20.5	33.950
II. Hotter	9,693	17.8	34.510
III. Hotter	10,821	16.7	36.140
IV. Bright orange	12,006	15.6	37.460

COMPOSITION OF THE GAS.

	I.	II.	IV.
Hydrogen.....	38'09	43'77	48'02
Marsh gas	42'72	34'50	30'70
Olefines.....	7'55	5'83	4'51
Carbon Monoxide	8'72	12'50	13'96
Nitrogen	2'92	3'40	2'81

The gas analysis of No. III. was lost, but the illuminating power shows that it is intermediate in composition between II. and IV.

From this it will be seen that with the increase of temperature the hydrocarbons (the olefines and marsh gas series) gradually break up, depositing carbon in the crown of the retort, and liberating hydrogen, the percentage of which steadily increases with the rise of temperature.

This breaking down of the hydrocarbons does not proceed in any regular progression, bodies being built up as well as broken down during the action, the general tendency being, however, to form simple molecules until at last complete decomposition ensues, the higher members of the paraffin series being probably converted into paraffins and olefines of lower molecular weight. Butane, for instance, at a high temperature is resolved into ethane and ethylene, whilst at a still higher temperature ethylene will form ethane and acetylene, and still further break up into methane and carbon, the methane itself being at last broken up. Indeed the heavy hydrocarbons undergo such analytical and synthetical changes at a high temperature that, given any member of the series, you may have it resolved into carbon and hydrogen under one set of circumstances, whilst under others methane may become converted at high temperatures into naphthalene and acetylene, and it is this fact which gives such varying composition to the illuminants present in the gas.

3. The length of time during which the gas is in contact with the heated sides of the retort and with the liquid products of distillation.

When once evolved, the gas should not remain longer than necessary in the retort, as the sides being at a higher temperature than the charge, the hydrocarbons present become broken down in the way previously indicated with deposition of carbon in the crown of the retort. If the gas remains in contact with the tarry products of distillation, the tar will absorb a considerable amount of the volatile

hydrocarbon vapour and seriously impair the illuminating value of the gas, becoming itself much more liquid, so that the gas should be removed from the presence of tar before the latter has time to cool.

All analyses of coal gas have so far been founded on the assumption that the "illuminants," *i.e.*, the heavy hydrocarbons responsible for the illuminating power, could be absorbed by fuming sulphuric acid, chlorine, or bromine. This, however, is undoubtedly not the case. Mr. Wright has shown that when coal gas has been treated with fuming sulphuric acid, the residual gas still retains from 32-55 per cent. of its original luminosity, and although this may be to a certain extent due to the methane, which at high temperatures becomes slightly luminous, still it is certain that a considerable percentage is due to the higher members of the paraffin series not absorbed by the fuming sulphuric acid, and which the methods of analysis usually employed utterly fail to detect. Indeed, given a gas containing any member of the paraffin series other than methane, the analytical results are not only incorrect, but very misleading, as the percentages of hydrogen and methane present will be absolutely nullified by a very small quantity of the higher hydrocarbons.

In the analysis of an illuminating gas of the kind generally supplied up to a few months ago, the general process of analysis consisted in taking a measured volume of the gas over mercury, and

1. Absorbing sulphuretted hydrogen by manganese dioxide impregnated with phosphoric acid.

2. Absorbing carbon dioxide by potash.

3. Absorbing oxygen by alkaline pyrogallate.

4. Absorbing the "illuminants" with sulphur trioxide dissolved in Nordhausen sulphuric acid, and washing the remaining gas with potash to remove any sulphur dioxide from the acid used.

5. Absorbing carbon monoxide with acid cuprous chloride.

The residual gas was then looked upon as consisting of methane, hydrogen, and nitrogen, and was exploded with excess of oxygen over mercury. The volume of carbon dioxide formed was estimated by absorption with potash, and gave the volume of methane, whilst the residual gas, after the removal of excess of hydrogen by potassic pyrogallate was looked upon as nitrogen, and the hydrogen was obtained by difference. This method, as employed by Bunsen, gave results which were

approximately correct, but inasmuch as the absorbents had to be introduced into the measuring eudiometer on various absorbent substances, and as it was also hampered by a mass of necessary corrections, the time taken by an analysis was enormous. The results also, when obtained, gave practically no insight into the composition of the gas, and this method, as well as the succeeding ones, was open to a grave objection which will be discussed later on. The first steps towards simplifying the process were made by Prof. MacLeod in his modification of the Frankland-Ward apparatus, and was still further improved upon by Mr. Thomas, but the apparatus still remained too ponderous, and the process too long for technical analysis, where the operation must be performed in at most two hours, in order to be of use to the gas manager or experimentalist desirous of checking the actions going on in any process. The next step was the introduction of Stead's apparatus, in which mercury was used, and in which also very convenient arrangements were made for transferring the gas to the laboratory vessels, and bringing them back to the measuring tube eudiometer; and, finally, accuracy has been still more sacrificed to speed in the Orset-Meucke and Hempel's burette, which atones, as far as possible, for the errors introduced from the use of water instead of mercury, by the large volumes of gas which can be worked with at a time.

The processes instituted by Bunsen, and used with all forms of mercury apparatus, have several drawbacks, the chief one being that the residue left after absorption with cuprous chloride was looked upon as hydrogen, methane, and nitrogen, and that these were estimated by explosion with oxygen, and the volume of carbon dioxide formed was taken as representing the volume of methane.

Now all researches on the composition of coal gas point to the presence of ethane, and probably higher members of the marsh-gas series, whilst in carburetted gases they are undoubtedly present to a far higher extent.

Ethane, propane, and butane, have all been shown to be present in small quantities, and as ethane gives double its own volume of carbon dioxide, propane three times, and butane four times its volume, it is evident that exploding with oxygen, and taking the volume of carbon dioxide as representing marsh gas, will undoubtedly give too high results with an ordinary coal gas, whilst with a carburetted

gas it will render the whole analysis useless; moreover, the free oxygen is next absorbed and the remainder taken as nitrogen, whilst the volume of gas after absorption by cuprous chloride, less the marsh gas, and nitrogen obtained as above is taken as representing the hydrogen in the gas. The result being that the hydrogen is always far too low, not only because the volume of marsh gas is too high, but also because the residual nitrogen having to bear the brunt of all the errors of analysis throughout some seven or eight absorptions is also nearly always too high.

These palpable errors in the quantity of marsh gas and hydrogen also render worthless the calculation of the carbon and hydrogen density of the gas, on which great stress has been laid by previous observers, so that on the whole it is not to be wondered at that no relation has been discovered between the carbon and hydrogen density and the illuminating value of the coal gas.

With the more rapid methods of technical analysis, it is evident that no explosion over water and subsequent measurements of carbon dioxide could give satisfactory or even approximate results, as the pressure at the moment of explosion, and subsequent reduction of pressure, causes the water to effervesce like soda-water, from the absorption, and then liberation of the carbon dioxide; and as this washes other gases dissolved in the water out of it, and leaves an indefinite quantity of carbon dioxide in solution, any such process must be discarded.

These troubles have induced chemists to suggest several modifications in the process, some of which aim at doing away altogether with explosion. Some of these, like the process of burning H., but not methane, by passage over palladium asbestos, are of great value, whilst others are of not much practical value. The last method proposed for the analysis of coal gas, without explosion, was published this year, and consisted of—

1. Absorbing the illuminants by strong alcohol.
2. Absorbing carbon dioxide by potash.
3. Absorbing oxygen by pyrogallate of potash.
4. Absorbing carbon monoxide by cuprous chloride.
5. Absorbing hydrogen by alkaline solution of permanganate of potash, and calling the residual gas, methane and nitrogen.

The objections to this process are, that alcohol not only absorbs the illuminants, but

also a very large per-centage—say 50 per cent.—of the methane, with considerable rapidity; that after washing with water from the alcohol vapours, it would be useless to expect an exact determination of carbon dioxide, as it has been mostly dissolved by the water; and finally, that, as far as my experiments have at present gone, alkaline permanganate is not a reliable absorbent for hydrogen.

I am, at the present time, working at the various processes of gas analysis and checking mixtures of pure hydrocarbons, work I hope to have ready for publication early next year; but so far the general scheme of analysis which I am following, and which gives me the best and most instructive results, is as follows:—

Two Stead's apparatus are taken and placed with the entrance tubes end to end, and are filled, the one with distilled water saturated with air, and the other with clean pure mercury. The gas to be tested is collected in one of the Stead absorbing tubes over water, so as to be saturated, and is then transferred over mercury in the eudiometer tube of the apparatus, and is measured and passed into sodic hydrate, to absorb the small traces of carbon dioxide to be found in the highly purified London gas. (When present in only small traces, the amount of the carbon dioxide lost by water saturation cannot be detected.) After absorption of carbon dioxide the gas is run into the second apparatus, and the oxygen estimated by absorption with alkaline pyrogallate, which must be strong and fresh, containing about 25 grams of pyrogallic acid dissolved in 50 grams of sodic hydrate in 200 of water. (It is absolutely essential that the solution should be fresh, as, after keeping for some time, it will evolve a considerable amount of carbon monoxide.) After absorption with pyrogallate, the gas is run back into the eudiometer of the apparatus, and is measured over water. The heavy hydrocarbons have now to be estimated, and inasmuch as benzene is one of the most valuable illuminants in the coal gas, it would be of great value if any absorbent could be found which would separate the benzene and ethylene series; but unfortunately such does not, as far as we know, exist, the ordinary absorbents having the following drawbacks:—(1) Nordhausen sulphuric acid, in which sulphur trioxide has been dissolved until it will solidify on cooling, absorbs both ethylene and benzene, and therefore cannot be used to separate them.

(2) Fuming nitric acid is a good absorbent for both series. (3) Bromine water, or a potassic bromide solution of bromine, acts more rapidly on ethylene than on benzene; but undoubtedly does absorb a considerable quantity of the latter if in contact with a mixture of the two. (4) None of the above affect the methane series in diffused daylight. The nearest approximate result is obtained by treating the gas first with strong bromine water, but not leaving it too long in contact with it, and then removing bromine vapour over sodic hydrate, the absorption being taken as ethylene series; whilst the benzene is then absorbed by fuming nitric acid, or saturated Nordhausen acid, acid fumes being removed in the sodic hydrate tube before measurement over water. It is then passed into an absorption tube, filled with a fresh solution of ammoniacal cuprous chloride, to absorb carbon monoxide. (This must not be used for more than six determinations of an ordinary coal gas containing say, 3 to 6 per cent. of carbon monoxide, or three of a carburetted water gas, as after much carbon monoxide has been absorbed, the solution has a tendency to again give up small quantities of the gas.) The gas is now returned to the mercury eudiometer tube, and, after measurement, is passed into an absorption tube with paraffin oil previously heated, until everything which will distil at 100° C. has gone off, which absorbs ethane, propane, and a good deal of methane. The residue is now washed and mixed with oxygen (which has itself been analysed, so that the per-centage of nitrogen and foreign gases in it are known), the mixture is exploded over mercury, and the carbon dioxide formed is estimated. The volume of carbon dioxide formed, plus the volume of gas absorbed by the paraffin oil, then gives the volume of gases in the methane series. A fresh portion of gas is now taken over mercury, and is exploded with excess of analysed oxygen, the carbon dioxide is absorbed by sodic hydrate and the oxygen by pyrogallate, and the residue will be the nitrogen, the hydrogen being determined by difference.

It must, however, be clearly borne in mind that any such separation of the ethylene and benzene is not in any way accurate. The absorptions by bromine water and nitric acid, when added together, give the true quantity of olefines, whilst the volume absorbed by the paraffin oil added to the volume of carbon dioxide found during explosion, gives accurately the volumes of gases in the methane series, but

beyond this any subdivision of the constituents is purely approximate. In this way an analysis of South Metropolitan gas shows : —

Illuminants	Hydrogen	47.9	Total Hydrocar- bons. 45.6 per cent.
	Ethylene series {	approx. 3.5	
	Benzene " {	0.9	
	Methane series {	by paraffin 7.9	
		by explosn. 33.3	
	Carbon monoxide...	6.0	
	Carbon dioxide ...	0.0	
	Oxygen	0.5	
	Nitrogen	0.0	
100.0			

In such an analysis no pretence is made that the exact per-centage of the various illuminants is given, but the total of the illuminants is accurate, and their rough subdivision gives a far clearer insight into the characters of the gas than the more pretentious and more faulty analysis we have been in the habit of arguing upon.

It must be clearly borne in mind that I only put this scheme of analysis forward to meet the need now rapidly arising for a method which will show whether we are dealing with an ordinary coal gas enriched by cannel, a coal gas carburetted with either gasoline or oil gas, or with a coal gas enriched by highly carburetted water gas. In the first case the ethylene and benzene series will be found well represented, whilst the carbon monoxide is low. In the second the amount of hydrocarbons in the methane series will have increased, and if oil gas has been used, a small increase in carbon monoxide may also be noticed, whilst the presence of carburetted water gas at once brings up the quantity of carbon monoxide, and the members of the methane series become the important illuminants. The illuminating value of the hydrocarbons present in the coal gas vary very greatly, the illuminating power increasing very rapidly with the number of carbon atoms in the molecule, and a rough idea of the value of the hydrocarbons in the various series may be obtained from the illuminating values of those experimented with by Frankland and Thorne, Knublauch, and others.

ILLUMINATING VALUE OF HYDROCARBONS PER 5 CUBIC FEET OF VAPOUR.

Methane	5.2 candles.
Ethane	35.7 "
Propane	56.7 "
Ethylene	70.0 "
Benzene	420.0 "
Toluene.....	741.7 "
Naphthalene.....	990.9 "

The two latter being calculated from Knublauch's figures. From this it is seen that the illuminating value of benzene and the other hydrocarbons of that series are enormously more valuable than members of the methane series, and there is little doubt but that these bodies carried as vapours by the gas are the most important of the illuminants, their presence being amply proved by the fact that on compressing coal gas under a pressure of 14 atmospheres, *i.e.*, 14×15 lbs. on the square inch, benzene, xylene, and other members of that series can be separated out as a liquid.

The action of the diluents present in coal gas upon its illuminating power has been determined by taking ethylene with an illuminating power of 68.5 candles, as a representative of the hydrocarbons present in coal gas, and diluting with the various diluents present in coal gas. By this process the following results were obtained by Dr. Percy Frankland :—

COMBUSTIBLE DILUENTS.

Diluent.	Per-centage Ethylene.	Per-centage Diluent.	Candle-power per 5 c.ft. per hour.
Hydrogen ...	77.55	22.45	54.58
	68.39	31.61	49.37
	53.58	46.42	39.21
	35.47	64.53	30.85
	26.08	73.92	22.84
	13.37	86.63	6.73
	10.0	90.0	0.00
Carbon mon-oxide	81.65	18.35	55.27
	67.75	32.25	47.73
	46.30	53.70	33.09
	37.94	62.06	26.52
	28.73	71.27	13.26
	23.89	76.11	6.56
	20.0	80.0	0.00
Methane	85.67	14.33	57.91
	69.09	30.91	47.88
	57.74	42.26	40.42
	35.90	64.10	33.17
	13.00	87.00	19.35
	7.87	92.13	17.59

These results show that, with the combustible diluents, hydrogen reduces the illuminating power least with large quantities of the hydrocarbons, but that methane is preferable when in excess, as with low per-centages of the illuminant, especially when burnt at a high temperature, methane itself becomes a feeble illuminating agent.

This is due to the fact that, although, when the marsh gas or methane burns at ordinary temperatures, it is non-luminous, at a high temperature, some of it is broken up into acetylene, which gives it distinct luminosity.

Carbon monoxide is the most injurious of the combustible illuminants, 80 per cent. mixed with ethylene rendering it non-luminous, a result which would require 90 per cent. of hydrogen.

The influence of incombustible diluents on the illuminating power of flames containing hydrocarbons has been also determined, with the following results :—

NON-COMBUSTIBLE DILUENTS.

Diluent.	Per-centage Ethylene.	Per-centage Diluent.	Candle-power per 5 c. ft. of Gas.
Carbon dioxide ..	93·68	6·32	55·52
	90·59	9·41	51·81
	89·03	10·97	49·98
	81·73	18·27	42·81
	70·75	29·25	33·23
	64·14	35·85	26·52
	52·94	47·06	14·72
	45·61	54·39	7·49
Nitrogen	40·0	60·0	0·00
	84·69	15·31	51·96
	71·12	28·88	39·58
	59·93	40·07	29·64
	47·08	52·92	20·81
	36·24	63·76	11·82
Oxygen	28·81	71·19	7·20
	82·57	17·43	70·93
	80·67	19·33	72·53
	75·51	24·49	74·19
	68·50	31·50	71·17
Air	60·69	39·31	Explosion.
	79·68	20·32	54·45
	67·15	32·85	45·84
	55·92	44·08	37·16
	42·69	57·31	26·78
	33·91	66·09	16·22
	22·31	77·69	0·61
	13·31	86·69	Explosion.

Whilst moisture when present to the extent of 2 per cent. (the proportion present in coal gas saturated at 20° C., and 760 mm.) in ethylene, reduces the illuminating power 3·6 per cent., or in coal gas 3·3 per cent.

Of the inert or non-combustible diluents, therefore, carbon dioxide is the most injurious, and atmospheric air is the least harmful.

Wurtz has also determined the loss of light incidental on addition of air to coal gas, and gives the following results :—

Added air.	Per-centage loss of light.
3·00	15·69
4·96	23·83
11·71	41·46
16·18	57·53
25·00	84·00

The addition of oxygen to gases rich in hydrocarbons causes an increase in the illuminating power, up to a certain point. The temperature of the flame is increased by burning up the hydrogen of the hydrocarbons, and rendering the carbon incandescent without diluting the flame with nitrogen to the extent which would have been necessary had air been used for the purpose.

The effect of such gases as hydrogen, marsh gas, and carbon monoxide is simply to dilute the flame and, by separating the molecules of the hydrocarbons, to make them more difficult to decompose; whilst such bodies as the carbon dioxide, nitrogen, air and water vapour not only dilute but also cool the flame, as they do not add to the heat by any action of their own, and have to be heated up to the same temperature as the flame itself.

Rosette determined the temperature of a gas flame diluted with air, nitrogen, and carbon dioxide respectively, and found that it was least with the carbon dioxide and highest with air, a result which agrees with Dr. Frankland's determination of illuminating power. His figures are :—

Volumes taken.		Temperature.		
Gas.	Diluent.	Air.	Nitrogen.	Carbon dioxide.
		° C.	° C.	° C.
I vol.	I vol.	—	1,180	1,100
I „	2 „	1,260	1,150	880
I „	3 „	1,116	1,040	780

Miscellaneous.

HOME INDUSTRIES IN GERMANY.

The United States Commercial Agent at Mayence says in his last report that one of the marked features of industrial life in Germany is the making of articles in what is known as home industry, in which descrip-

tion of work many thousands of people—men, women and children—are engaged. This home industry is the making of different articles at home, frequently in out of the way places and villages, often in mountainous regions, where the people are poor and get a precarious livelihood from the soil. The work is generally done by hand, but the use of simple machinery does not take it out of the category of home industry, so long as it does not assume the form of regular factory work. The work may be done alone or with the aid of the family, and even hired labour may be used, provided the employer works in the double capacity of worker for another and an employer of workmen. The workers in home industry provide their own raw materials, or these raw materials are supplied by the tradesmen and manufacturers for whom the work is performed—both are customary. The articles made may be executed on orders, or made up with a view to the sale of them to the first dealer who comes. As regards the distribution of the home industry, it is carried on chiefly in that part of the empire which extends from the basin of the Glatzer mountains along the Bohemian frontier to the Fichtel-Gebirge, and thence northwards to the Eichsfeld, taking in Liegnitz, Breslau, Bautzen, Dresden, Leipsic, Zwickau, Upper Franconia, and the Thuringian States, as well as the Prussian district of Erfurt. In addition, a few large home industrial districts are met with on the western frontier, such as those of Düsseldorf, Aix-la-Chapelle, Lower Alsace and Lorraine, as well as in the Black Forest. In the cities of Berlin and Bremen, home industries are largely engaged in. In the districts of Bautzen, Liegnitz, and Breslau, it is chiefly the making of linen and cotton goods that occupies the people; in the districts of Zwickau and Leipsic, and in the two Reusses and in Saxe-Weimar it is the making of hosiery, and of cotton and woollen goods; in the district of Erfurt and in Schaumburg-Lippe, it is the linen industry that mostly prevails; in a part of Thuringia, it is the making of toys. The home industry on the Lower Rhine, as at Düsseldorf and Aix-la-Chapelle, is chiefly devoted to the making of silk goods and small iron ware, such as tools, scythes, and cutlery. In Lorraine and Lower Alsace, the people are mostly engaged upon wicker-work, crocheting and embroidery; to some extent, also, in weaving cotton cloth. In the Black Forest it is especially shoe-making that is met with; in Berlin, the making of wearing apparel, and in Bremen the making of cigars. In all Germany there are said to be 10·5 persons engaged in home industry to every 1,000 inhabitants, the largest proportion being in Saxony. A large number of women are employed in home industry. In every hundred persons engaged 43·9 are females; while of every hundred persons engaged in all industries, only 20 are females. In home industrial work requiring strength, 90 per cent. of the workers are men; while in the lighter employments, 90 per cent. are females. In general

industry, 59 per cent. of the workers are unmarried, 38·6 per cent. married, and 2·4 per cent. those who have lost their partners; while, in home industry, 40 per cent. of the workers are unmarried, 47 per cent. married, and 13 per cent. those who have lost their married partner. In home industry there is relatively a less number of children under fifteen years of age employed than in general industry. In the former, among a total of 339,644 workers, only 4,449 are under fifteen years of age—that is, 1·3 per cent.; while of 4,096,243 persons in general industry, 138,396 are less than fifteen, or 3·4 per cent. The hours of labour in home industry are, in many instances, excessively long. The Thuringian wood-carvers sit at their work all day and late into the night. The slate-makers work eighteen hours a day. The basket makers in Upper Franconia and Coburg rise in summer at half-past four and work late into the night. Workers in meerschaum at Rhula work generally fifteen or sixteen a day in summer, and thirteen hours in winter. The wages paid in home industry are very low, and enable the recipients only to drag out a miserable existence. In Thuringia the weekly earnings of the toy-makers in the Sonneberg district are as follows:—An embosser, aided by wife and children, twelve to fourteen shillings; a turner, from seven to nine shillings; a female worker on dolls' hair, three shillings and sixpence to four shillings; a slate-maker, six shillings; and a paper-box maker, three shillings. At Rhula, the best makers of meerschaum pipes earn, when they have full employment, from eighteen to twenty-one shillings a week; ordinary workmen, twelve shillings, and inferior workmen only about eight shillings. The earnings of a family of wood-carvers in the Eisenach district, consisting of five members, is said to be from fourteen to sixteen shillings a week, when they have full employment, and are of the better class of workers. The inferior class of carvers hardly make enough to pay for bread. Cork-cutters in the same district are still worse paid, a whole family of them receiving only from five to eight shillings a week.

THE NICARAGUA CANAL.

The last number of *Engineering* contains a full account of the proposed Nicaragua Canal, from which the following particulars are taken:—

“The idea of cutting a waterway through the isthmus connecting the two continents of North and South America has been revived every few years since the contour of the new world was definitely established. Cortez himself sought for a natural way along the rivers which flow in either direction to the sea in the neighbourhood of Tehuantepec, and finding none, he purchased large tracts of land as an inheritance to his posterity, confident that, in time, the needs of the world and the advance of science would carry a highway over this spot. If Mr. James

B. Eads had lived there is little doubt that Tehuantepec would have become the site of a ship railway; possibly it may still, but for the present that project is quiescent. No less than nineteen schemes for crossing the isthmus had been put before the world up to 1866, and since then there have been several others. The following is a list of the most practicable schemes, named geographically from north to south:—

1. The Isthmus of Tehuantepec.
2. The Nicaragua route *via* Lake Nicaragua.
3. The Isthmus of Panama.
4. The San Blas and Chepo route.
5. The Caledonia Bay and Morti routes.
6. The Caledonia Bay and Sucubti route.
7. The so-called "Du Puydt" route.
8. The Cacarica and Tuyra route.
9. The Atrato and Fernando route.
10. The Atrato-Napipi route.

"In 1879 an international congress sat in Paris to determine the best route for a canal connecting the two oceans. The various possible courses were discussed; the American delegates advocated the claims of the Nicaragua site, while the French preferred that of Panama. Eventually the supposed possibility of cutting a canal at the latter place, entirely free from locks, weighed so greatly in its favour, that it was adopted. Every one knows what the result has been. First, the straight cut, without locks, was abandoned; and now all work is suspended, with no probability of its being resumed.

"The Panama Canal was never popular in the United States, the general feeling there being in favour of the Nicaragua route; and this was intensified when the development of the Pacific States rendered improved means of communication across the continent imperatively necessary. The trans-continental railways have not sensibly decreased the necessity for a shortened sea route, since their charges are prohibitive for many classes of heavy goods. As early as 1849, the Government of the United States encouraged the formation of the Atlantic and Pacific Ship Canal Company, which obtained a concession from Nicaragua. The surveys were made by Colonel O. W. Childs, who determined the lowest point at which the range running down the isthmus could be crossed to be 152 feet above sea level. He laid down a route for the canal from the mouth of the River Lajas, on the west shore of the lake, to the port of Brito on the Pacific; and, although nothing further was done, the surveys have not only proved valuable, but also exceedingly accurate. Further surveys were made between 1870 and 1876. In 1872, President Grant appointed a Commission to report on the various plans submitted by the various surveying parties, and in 1876 the Commission reported that "the route known as the Nicaragua route possesses, both for the construction and the maintenance of a canal, greater advantages, and offers fewer difficulties from an

engineering, commercial, or economical point of view, than any other of the routes shown to be practicable by surveys sufficiently in detail to enable a judgment to be formed of their relative merits." The routes considered were the first, second, third, and tenth, given above.

"The route selected was 181 miles in length, and involved four dams across the river San Juan, with twenty-one locks of 10 feet lift, ten on the Atlantic, and eleven on the Pacific slope. The chief engineer of the Government surveys, Mr. A. G. Menocal, still considered that improvements might be made in the route by more detailed examination, and in 1880 he was able, in the western division, to effect a decrease in the length and in the amount of excavation, and also to render the curves easier. In 1885 he attacked the eastern side, and was so successful, that soon afterwards a company was chartered for the building of the canal. The first work to be done was to supplement the early surveys by others of a most detailed and minute character, designed to establish every feature with the utmost exactness, and to eliminate every unknown element from the problem. For two years and a half, nine parties of surveyors were constantly engaged on this work, and actually surveyed by transit and level not less than 4,000 miles of lines, although the axial distance of the land survey is less than 50 miles. This painstaking course is very different from the hurried way in which the Panama route was marked out.

"The length of the canal is:—

	Miles.
Eastern division	18,864
San Francisco division	12,500
Lake and river.....	121,040
Western division.....	17,040
	<hr/> 169,444

Of this length 155 miles are on the summit level of 106 feet above the sea. This is the level of the dam at Ochoa, the lake being some 4 feet higher to provide slope for the waters to run off.

"In calculating the capacity of the canal, it is assumed that the entire transit can be made in 28 hours. This allows 45 minutes for each lockage and 1½ hours for detention in the narrow cuts. The speeds vary from 5 miles an hour over 26 miles, to 10 miles an hour through 56 miles in the lake. The traffic on the canal will be limited by the time required for a vessel to pass the lock. If this be 45 minutes, then 32 vessels can pass per day of 24 hours, which at the average tonnage of the vessels using the Suez Canal, will give 20,440,000 tons per year. This is three times the traffic of the Suez Canal, which, in 1888, amounted to 6,640,834 tons. Estimates of the probable traffic on the Nicaragua Canal in 1895 put it between 6,000,000 and 7,000,000 tons. Assuming a charge of 10s. per ton, this would bring in a revenue of £3,000,000 sterling gross, or £2,800,000 net. This would pay 5 per cent. on a capital of £56,000,000 sterling. No official estimate

of the cost has been put forward, but the sum of £12,000,000 to £15,000,000 sterling is mentioned. This certainly appears very small against £6,000,000 for the Manchester Canal, £20,000,000 for the Suez Canal, and forty or more millions for the incomplete Panama Canal. Apart from constructional advantages, however, Nicaragua is far better situated in respect of climate than Panama. On the west, the climate is warm, with a moderate rainfall. It is constantly swept from the east with the trade winds, which render the nights cool, and carry off all miasma that may exist. The eastern side is distinctly wet, with some intermittent fever, if the rules of health are not observed. This is more particularly true of the flat plain close to the sea. Once the hills are reached, when the bulk of the work will have to be done, there should be no difficulty in avoiding tropical disease.

"The Nicaragua Canal is no longer a scheme in the air. Large sums have been spent on preparations; and those who have it in hand have no fear of raising the capital as it is required. Five miles of railway have been built, and a bridge has been constructed across the Juanillo River, preparatory to carrying the railway forward. Storehouses have been built, and a machine shop is in course of construction. A large wharf and pier have been erected, and connect the railway with deep water in the harbour at Greytown, so that goods can be unloaded direct into trucks. Six of the immense American dredgers, which did such good work on the Panama Canal, have been purchased, and one has already arrived. A good deal of machinery and stores are likely to follow from the same source. Quite recently a dredger for the canal was launched at Renfrew by Messrs. Simons and Co."

Members of the Society will remember that the late Admiral Bedford Pim read a paper on the Panama Canal before the Society in December, 1879, in which he described the various attempts to canalise the isthmus.

COMMERCIAL AND INDUSTRIAL CONDITION OF HUNGARY.

The Turkish Consul-General at Budapest has recently addressed to Saïd Pasha, Foreign Minister at Constantinople, a report upon the "Commercial and Industrial Condition of Hungary." He states that Hungary is one of the most fertile countries in Europe, the agricultural production of which is in excess of the demands for consumption. The area of the country is 322,285 square kilomètres (124,402 square miles). The extent of land under corn crops amounts to about 20,000,000 acres, and under vines, to 898,000 acres. The population exceeds 16,000,000, and it increases annually by 100,000 persons. There are 15 chambers of commerce in the country, all of which are well supported, and render considerable assistance to the development of

trade. The principal agricultural products of Hungary are wheat, rye, barley, oats, colza, millet, maize, flax, hemp, tobacco, beet-root, and potatoes. The Hungarian wheat is considered the best of all wheats. It owes its superiority to the large quantity of gluten it contains. Barley also enjoys a well-merited reputation, and plays a very considerable rôle in the grain trade of the country. Maize is a source of wealth to the growers in the east and north-east. Rice cultivation was attempted some years ago, but for some time it was abandoned, until the Government undertook it; and recently the cultivation of rice has been engaged in by private persons. It is stated that this particular branch of the agricultural industry has a brilliant future in Hungary. The cultivation of colza has lost much of its old importance, and shows a falling-off each year. At the present time it is only cultivated in the south. Sugar beet is grown in Presbourg and Oldenbourg, where good crops are yielded. Hungarian tobacco has greatly fallen off as regards quality, the sole aim of the growers appearing to be to increase the quantity without reference to quality. In Hungary, as in many European countries, the tobacco cultivation is a monopoly. No person may engage in the cultivation of tobacco without a special permit, and growers may be authorised to produce (1) for the use of the Régie, (2) for export, and (3) for private consumption. The quantity imported by the Régie, in addition to that grown in the country, is about 4,000,000 kilogrammes annually, chiefly derived from Cuba, Java, Sumatra, Manilla, Virginia, Kentucky, Turkey and Russia. The Government own four large breeding establishments, divided into two sections—horse-breeding establishments and cattle-breeding establishments. The production of wool is an important industry in Hungary. Formerly the wools of this country were classed in two distinct categories—mountain wools very long and well-known, derived from native Hungarian sheep, and wool of excessive fineness, obtained by the introduction of the *negretti* ram. These two types are still in existence, but other descriptions, owing to the exigencies of the trade, have been introduced. The principal wool market in Hungary is held at Budapest. The soil and the climate of the country are alike favourable to the rearing of the silkworm; the first attempts to introduce this industry were made in the 17th century, in the neighbourhood of Témessvár. Hungarian silk is of very superior quality, and is held in high repute in industrial circles. Hungary produces wines which possess very excellent qualities; unfortunately, however, for this industry, the phylloxera has invaded the vineyards, and has caused considerable injury and loss. The working of the forests, which cover an area of 22,000,000 statute acres, exclusive of Croatia and Slavonia, constitutes one of the most important branches of Hungarian commerce; while the mineral water industry is equally a source of wealth to the country. The most important of the springs is that

which is known as "Hunyadi Janos." The flour trade is also in a prosperous condition in the country. There are in Hungary and Transylvania (exclusive of Croatia) 17,277 mills, of which 810 are worked by steam, and the remainder by wind, water, or horses. The total production of these mills might reach 60,000,000 quintals (the quintal is equivalent to 220 lbs. avoidupois), but of late years it has not exceeded 23,000,000 quintals. As regards the mining industry, there are mines of every description, and particularly of the precious metals. Gold and silver are found in Presbourg, Debreczin, and Transylvania. The annual production of gold is valued at 6,000,000 francs, and of silver at three millions. Rock salt is abundant in Hungary, and its working constitutes a State monopoly. Coal is found in many places, principally at Pesth, Miscolez, Funfkirchen, Ténésvar, and Arad. At Orsova, beds of chrome are frequently met with.

THE MEXICAN LEATHER INDUSTRY.

According to a report recently prepared by the Belgian Minister in Mexico, the export of Mexican leathers has lately exhibited a considerable development, and in his opinion, although there has been great progress made in this industry, it will still further advance, as Mexico, owing to its cattle rearing, stands in a particularly favoured position. The export trade, however, at present suffers from the defective manner in which the hides are treated before shipment. The consignees complain that they are only able to use about one-fourth of the leathers, on account of the numerous cuttings in them. Again, many hides treated in Mexico grow hard and tough, because they are dried in the sun instead of in the shade. It is from Tehuantepec and Oaxaca that the best leathers come; they are strong and of good quality, but it is found advisable to export them in the dry state, as those which are exported tanned can with difficulty be employed for industrial purposes. A large number of hides are sold to the United States as coming from Central America, when in reality they come from Mexico. The export of hides is effected for the most part through the ports of Tampico, Vera Cruz, and Matamoros, as well as by the northern frontier. The most highly valued of the Mexican leathers for strong boots are those which come from Matamoros and Tampico; they are heavy and large. For light shoes, the leathers from Vera Cruz are preferred, while for women's and children's shoes it is the goat-skins of Matamoros, Tampico, and Vera Cruz which are the most sought after. Within the last few years European and American industries have commenced to make considerable use of the *caiman*, or crocodile skin, the qualities of which have been known for some time, but which had not hitherto been much used. Almost all parts of the body of the *caiman* are utilised; the teeth are made up, in conjunction with gold, into ornaments and articles of jewellery, such

as pins, ear-rings, &c., and these find a ready sale. It is said that the oil which comes from the fat of the *caiman* has medicinal properties; at all events it is highly appreciated for the manufacture of soap. A *caiman* of ordinary size supplies about 80 lbs. of fat, but the principal product is its skin, which offers a very great resistance, and is used generally for making *articles de Paris*, travelling bags, purses, &c. This skin is naturally figured, and this can only be imitated with difficulty by artificial means. It has a very variable market value, because of the irregularity of the supply. Mexico also supplies another animal which bears much similarity to the *caiman*, namely, the iguana, but its skin offers infinitely less consistency than that of the *caiman*. The latter abounds in Mexico, where hitherto little benefit has been reaped from it. The whole of the Pacific coast, and all the lagoons are infested with *caimans*, thus, as the Belgian Minister points out, all the elements of a lucrative industry are found, especially as the industry in question requires very little capital.

Obituary.

ARCHBISHOP OF YORK.—Dr. William Thomson, Archbishop of York, who died at the Palace, Bishopsthorpe, on Christmas Day, in the 72nd year of his age, was for many years a member of the Society of Arts. He was the first Examiner in Logic and Mental Science, appointed by the Council in 1860, and he held the appointment until his translation from the Bishopric of Gloucester and Bristol to the Archiepiscopal see of York, at the end of 1862. As full descriptions of the life and work of the Archbishop have appeared in the newspapers, it is not necessary here to do more than refer to the part he took in the Society's examination work.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

JANUARY 14.—J. F. GREEN, "Steam Lifeboats." PROFESSOR ELGAR will preside.

JANUARY 21.—A. G. GREEN, C. F. CROSS, and E. J. BEVAN, "Photography in Aniline Colours." CAPT. ABNEY, C.B., F.R.S., will preside.

JANUARY 28.—CARMICHAEL THOMAS, "Illustrated Journalism." LUKE FILDERS, R.A., will preside.

FEBRUARY 4.—T. EMERSON DOWSON, "The Growing Need for Decimal Coinage, Weights, and Measures."

Papers for which no dates have as yet been fixed:—

"The Sources of Petroleum." By WM. TOPLEY, F.R.S.

"Methods and Processes of the Ordnance Survey." By COLONEL SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S.

"Lands available for Colonisation." By E. J. RAVENSTEIN.

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"The Use of Petroleum in Prime Motors." By WILLIAM ROBINSON.

"Electricity in relation to the Human Body." By H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D.

"The Proposed Irish Channel Tunnel." By SIR ROGER LETHBRIDGE, M.P.

"Milling Machinery." By J. HARRISON CARTER.
"Harbours, Natural and Artificial." By F. H. CHEESWRIGHT.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock :—

JANUARY 20.—WILLIAM H. WYLDE, C.M.G., "The Opening of Africa."

FEBRUARY 17.—COMMANDER V. LOVETT CAMERON, C.B., "Chartered Companies in Africa."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Papers for which dates are not yet fixed :—
C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

LEWIS ATKINSON, "The Diamond Fields of South Africa."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

JANUARY 22.—EDWARD J. WATHERSTON, "Hall-marking of Silver Plate, with special reference to India." SIR THEODORE CRACRAFT HOPE, K.C.S.I., C.I.E., will preside.

FEBRUARY 26.—ROBERT GORDON, C.E., "The Economic Development of Siam." SIR CHARLES EDWARD BERNARD, K.C.S.I., will preside.

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. the LORD REAY, G.C.S.I., G.C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

JANUARY 27.—WILLIAM SIMPSON, "Lithography."

FEBRUARY 10.—HEYWOOD SUMNER, "Sgraffito." CHARLES BARRY, F.R.I.B.A., will preside.

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

CANTOR LECTURES.

The following Courses of Cantor Lectures will be delivered on Monday evenings at Eight o'clock :—

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

January 26; February 2, 9.

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

February 16, 23; March 2.

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

March 9, 16, 23.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 5... Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Percy Gilchrist, "The Basic Copper Process." 2. Mr. W. C. Young, "Standard Sperm Candles."

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. Prof. J. P. Mahaffy, "Herod and Cleopatra."

TUESDAY, JAN. 6... Royal Institution, Albemarle-street, W., 5 p.m. Professor Dewar, "Frost and Fire." (Lecture V.)

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. A. Boulenger, (i.) "Description of a new Lizard of the Genus *Ctenoblepharis*, from Chili; (ii.) "Some Chelonian Remains preserved in the Museum of the Royal College of Surgeons." 2. Mr. F. E. Beddard, "Contributions to the Anatomy of the Kagu (*Rhinocetus jubatus*)."

WEDNESDAY, JAN. 7... SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. Juvenile Lectures. Mr. E. B. Poulton, "Mimicry in Animals." (Lecture II.)

Geological, Burlington-house, W., 8 p.m. 1. Rev. E. Hill and Prof. T. G. Bonney, "The North-west Region of Charnwood Forest, with other Notes." 2. Prof. T. G. Bonney, "Note on a Contact-Structure in the Syenite of Bradgate-park." 3. Dr. Charles Callaway, "The Unconformities between the Rock-systems underlying the Cambrian Quartzite in Shropshire."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, JAN. 8... London Institution, Finsbury-circus, E.C., 6 p.m. Colonel Majendie, "Explosives and some of their Developments and Applications."

Royal Institution, Albemarle street, W., 3 p.m. Prof. Dewar, "Frost and Fire." (Lecture VI.)

SATURDAY, JAN. 10... North-East Coast Institution of Engineers and Shipbuilders, The Athenæum, West Hartlepool, 7½ p.m. 1. Mr. A. Leckie, "Salvage Steamers." 2. Mr. J. D. Young, "Mechanical aid to the Investigating of Experimental Curves."

Journal of the Society of Arts.

No. 1,990. VOL. XXXIX.

FRIDAY, JANUARY 9, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

INDIAN & FOREIGN & COLONIAL SECTIONS.

The attention of members is drawn to the alteration which has been made in the time of meeting of these two Sections. The meetings will be held during the present session at half-past four instead of at five o'clock, and it is hoped that the altered time will be found more convenient to the members.

JUVENILE LECTURES.

On Wednesday evening, 7th inst., Mr. E. B. POULTON, M.A., delivered the second and concluding lecture of his short course on "Mimicry in Animals." He commenced with a recapitulation of the chief points previously set forth, and then passed on to the subject of the second lecture, which dealt with Protective and Aggressive Mimicry. Protective mimicry helps the animal to avoid its enemies, and aggressive mimicry makes the animal attractive to its prey. A large number of lantern slides of Indian butterflies were thrown on the screen. It was shown that, in some instances, the male imitated the male, and the female the female of a particular species of butterfly, and in others the males imitated one kind of butterfly and the females another kind. In still other instances, the females, which most suffered from attack, alone mimicked the individuals of another species. All the moths which were subject to mimicry were unpleasant to the taste, and were thus protected from destruction by enemies.

The lecturer then explained what was really meant by the expression mimicry. The animals themselves were not, of course, active agents in this mimicry, but it was supposed that the

imitative animals had some rudimentary likeness to the animals imitated, and those in which the similar colours were most marked were protected, and those in which they were least marked were destroyed. By this means the characteristic colours gradually became more and more marked in the descendants of those that survived.

Instances were then shown of wasps and bees imitated by harmless insects, ants imitated by spiders, and spiders by caterpillars. A series of moths resembling wasps were shown. In these last, when the moths first came out of the chrysalis, their wings were covered with scales, but these scales, except at the edge, fell off, and left the wings transparent like those of the wasps. The process of evolution was thus seen in operation.

A fly which mimicked a humble bee was then shown, but this was an instance of aggressive mimicry, for the fly, by means of its disguise, gains admittance to the hole, and there lays its eggs, which live upon the humble bees' eggs. Another division of instances of aggressive mimicry was described as "alluring." Certain insects had on their bodies a bright-looking object like a flower, and when they hid themselves, but exposed the bright object, they attracted their prey to them. Another class of animals were then shown. A terrapin in the tanks at the Zoological Gardens afforded a good example of this manner of obtaining prey. The animal, with open mouth, would remain perfectly still, having all the appearance of a piece of rock, but in the creature's mouth were little threads like worms, which were kept in constant motion, and attracted fish straight into the animal's mouth. Some fish in the dark depths of the sea were supplied with phosphorescent lamps, which attracted other fish to their destruction. The last slide shown represented a procession of leaf-carrying ants, and by their side were some remarkable insects whose bodies mimicked the leaves, so that it was most difficult to distinguish the one from the other.

A vote of thanks to the lecturer for his interesting course of lectures was proposed by Mr. FRANCIS COBB, the chairman, and carried unanimously.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

GASEOUS ILLUMINANTS.

BY PROF. VIVIAN B. LEWES.

Lecture III.—Delivered December 8, 1890.

The fact that coal gas of an illuminating power, of from 14 to 16 candles, can be made under ordinary circumstances at a fairly low rate, whilst every candle-power added to the gas increases the cost in an enormous and rapidly growing ratio has, from the earliest days of the gas industry, caused the attention of inventors to be turned to the enrichment of coal gas. This, up to the present time, has been almost universally carried out in practice by an admixture of rich cannel coal with the ordinary gas coal in the retorts, and a consequent heavy increase in the cost of the gas, a 16-candle gas made by either of the two large metropolitan gas companies costing about 1s. 2d. a thousand cubic feet in the holder, whilst a 22-candle gas would be cheaply made at double that cost by the use of cannel. To make matters worse, cannel is rapidly increasing in price, and first-class qualities are not easily obtained.

The methods which have from time to time been advocated to replace the use of cannel in the enrichment of illuminating gas may be classified as follows:—

1. The carburetting of low power gas by impregnating it with the vapours of volatile hydrocarbons.

2. Enriching the gas by vapours and permanent gases obtained by decomposing the tar formed at the same time as the gas.

3. Mixing with the coal gas, oil gas, obtained by decomposing crude oils by heat.

4. Mixing with coal gas, water gas, which has been highly carburetted by passing it with the vapours of various hydrocarbons through super-heaters, in order to give permanency to

the hydrocarbon gases. These methods must now be considered in detail.

1. Carburetting the gas by impregnating it with the vapour of volatile hydrocarbons.

The first attempt to directly carburet or naphthalise coal gas in a rational way was made by Mr. Lowe in 1832, who suggested that a form of wet gas meter should be employed, but that the liquid used in it should be the lighter hydrocarbons obtained by distilling coal tar instead of water, the idea being that the poor quality coal gas in passing through the volatile spirit would take up a certain quantity of the vapour, and so become enriched. Practice, however, soon showed that a number of unexpected difficulties existed. The apparatus required too much attention to keep the level of the liquid constant, and also to keep the meter and pipes clean; the gas, also, in passing through a fresh charge of liquid took up so much of the hydrocarbon as to burn with a smoky flame, whilst after the gas had passed through the meter for some time, the illuminating power rapidly fell, and more harm than good was done to the gas. The process was also found to be too costly, and was rapidly abandoned.

Many inventors followed on the same lines, and in 1863, 1864, and 1865 the carburetting of coal gas was tried on a large scale, and many experiments were made by Dr. Letheby, who found that the quality of the naphtha employed had a marked bearing on the results obtained, as, although a naphtha with a low specific gravity and low boiling point yielded a large quantity of vapour to the gas, the illuminating value of it was very small; whilst naphthas with higher specific gravity and higher boiling point, although taken up to a far smaller extent, yet yielded a far higher illuminating power to the gas, this being due to the oils being mixtures of various hydrocarbons. If coal gas be passed through naphthas of various specific gravities, and the quantity taken up by the gas and the increase in illuminating power be determined, results are obtained as shown in the table on page 107, showing clearly that, if a liquid hydrocarbon of fairly high specific gravity and a boiling point of medium height, which would evaporate sufficiently fast, could be obtained at a reasonable rate, it would be the best to use; as not only would the great danger attendant on the use of light naphthas be done away with, but the service obtained would be far higher and the quantity used far less.

It must be clearly borne in mind in ap-

HYDROCARBONS FOR CARBURETTING.

Sp. Grav.	Boiling point. (Cent.)	No. of grains taken up by each foot of gas.	Per-centage increase in illuminating power.	
			Total.	For each gr. per cub. ft.
·698	63	20·1	33·9	1·69
·676	40	34·4	62·1	1·80
·869	102	12·1	40·8	3·37
·827	115	6·5	21·7	3·43
·808	117	6·1	21·0	3·60
·852	128	3·8	14·2	3·72
·869	107	9·2	34·9	3·79
·869	103	11·8	46·8	3·96
·816	119	3·4	14·4	4·23
·856	114	4·4	18·9	4·29
·814	105	7·0	33·5	4·78
·865	124	3·3	15·8	4·79
·845	90	12·0	65·3	5·44
·874	119	4·8	26·7	5·56
·879	93	9·5	53·2	5·60
·870	129	2·8	15·7	5·61
·862	121	3·3	20·4	6·16
·848	97	10·2	68·4	6·70
·861	117	2·3	18·8	8·17
·875	110	6·9	60·8	8·81

proaching this subject, that the evaporation of a hydrocarbon into a permanent gas, *i.e.*, a gas which does not liquefy within the ordinary range of temperatures, is neither a question of specific gravity nor of boiling point, although the latter has more to do with it than the former. It is purely a question of vapour tension. Most liquids when left to themselves, in contact with the atmosphere or other gases, gradually pass into the state of vapour and disappear, and those which evaporate the quickest are said to be the most volatile.

If ether is dropped upon an exposed surface it at once disappears, and causes by its evaporation considerable cold, and the lightest forms of naphtha do the same thing. Although this evaporation takes place with great rapidity in liquids of low boiling point, it must not be forgotten that many solids even have the same property, naphthaline, camphor, and iodine being cases which will occur at once to everyone's mind; and it must also be remembered that evaporation occurs over a very wide range of temperature, but there is a limit for each substance, below which evaporation does not seem to take place. So that in considering the suitability of a liquid for carburetting in this way, it is far more important

to determine its vapour tension than its specific gravity or its boiling point.

The great trouble which presented itself in the older carburetting systems was, that all the commercial samples of naphtha are mixtures of various hydrocarbons having each their own boiling point, and that therefore, when used in any of the old forms of carburetter, they gave up their more volatile constituents very freely at the beginning of the experiment, whilst the amount rapidly diminished as the boiling point of the residue became higher; so that, when 2,113 cubic feet of poor coal gas were passed through a naphtha having a specific gravity of ·869 and a boiling point of 103° C., the temperature during experiment being 22° C. = 72° F., the first 80 cubic feet of gas took up 23·2 grains of the naphtha, whilst the last 450 cubic feet only took up 7·3.

Another difficulty found, was the increase of evaporation with increase of temperature, as with an ordinary form of carburetter exposed to atmospheric change, the enrichment of the gas, which reached 54·4 per cent. in summer, with an average temperature of 72° F. (22° C.), fell in winter to only 22 per cent., with an average temperature of 37° F. (3° C.).

Of course, in these carburetters, a good deal depended upon the form of apparatus; and it was found, on trying different forms with the same naphtha, that, when the gas merely flowed through a box containing a layer of it, only about 3·2 grains were taken up; whilst with a carburetter in which the naphtha was sucked up by cotton fibre, so as to expose a large surface to the gas, as much as 22 to 23 grains were taken up in the same period of time.

One of the most important points noticed during these experiments was, that it was only a poor gas which could be enriched in this manner, and that if a rich cannel gas was passed through the naphtha, it was robbed of some of its illuminating power; a point also noticed and remarked upon by Mr. George Davis, in an important paper on the enrichment of coal gas, read before the Society of Chemical Industry on January 4, 1885.

Dr. Letheby's experiments were all directed to supplying the hydrocarbon to the gas at the burners just before consumption, but, as far as liquid hydrocarbons went, this was a failure at that time; and when revived on a small scale five years ago, it did not prove a very successful venture, although a liquid of more constant composition was employed. So far, the most successful method of carburetting

gas at the burner has been that introduced by the Albo-Carbon Company in 1878, in which solid naphthalene is vapourised by the simple contrivance of letting the flame heat a small plate of metal which extends into the albo-carbon chamber, and so volatilises the hydrocarbon and causes the vapour to mingle with the gas which is passing through the chamber. The naphthalene used in the albo-carbon system is prepared from coal tar, which is distilled, the first portions consisting of naphthas, &c., whilst the second portion is rich in phenols and cresols. The second distillate is again distilled, and the residue left becomes semi-solid, owing to the separation of naphthalene, which, on standing, separates and cakes on the top of the oil. This is then removed and pressed by hydraulic power in a hot press, each plate of which contains a steam pipe to heat it. The crude naphthalene so obtained is then distilled, but contains a number of impurities, which would cause it to turn yellow; to get rid of these impurities, it is melted and forced by steam pressure into a steam-jacketed cylinder, where it is washed in dilute alkali, to get rid of phenol, and then four times with strong sulphuric acid, to remove sulphonates, meta-naphthalene, &c., and is then water-washed, free from acid, these washings taking about seventy-two hours. The naphthalene now undergoes a final distillation, after which it is melted in steam-jacketed coppers, and is ladled out and cast into sticks in an apparatus of the same construction as the old-fashioned candle-machines, these sticks being afterwards cut into the smaller pieces used in the lamp reservoirs. This albo-carbon system has been entirely successful, and by it the illuminating power of coal gas can be increased nearly 60 per cent. The cost of naphthalene, or "albo-carbon," being something less than 3d. a pound, the process gives a very decided saving in expense, and is widely used, the only thing that can be urged against the system being the slight extra trouble of each week charging the receiver with the naphthalene. This, in itself, would prevent this or any other system of carburetting at the burner from becoming a universally adopted process, as no amount of economy will persuade an ordinary English servant, or, for the matter of that, householder, to take a little extra trouble, and any system of carburetting, to be thoroughly successful, must be applied to the gas in bulk before distribution.

In doing this, there are two factors to be

considered—the vapours added must be in such proportion to the gases which have to carry them, that no fear need exist of their being deposited by any sudden cooling of the gas, and care must be taken that the vapour added is not in sufficient quantity to throw out of suspension the volatile hydrocarbons in the gas. The carrying power of a gas depends entirely upon its constituents; for in the same way that liquids vary in their power of dissolving and carrying (*i.e.* keeping in solution) solids, so do gases vary in their power of bearing away the more volatile hydrocarbons.

If the carrying power of air be taken as unity, then the power of ordinary coal gas would be about 1.5, whilst hydrogen would be nearly 3.5; and it is manifest that attention must be paid to the ratio of the constituents present if gases of varying composition are to be carburetted to the same degree.

Mr. George Davis, in the paper quoted above, describes an experiment, in which, whilst passing large quantities of a 17-candle gas through pure benzene, he found that, after four-fifths of the carburetting fluid had been taken up by the gas, the residual one-fifth had a far higher boiling point, and that this was due to such hydrocarbons as toluene and xylene deposited from the gas, showing that the gas exercises a selective absorption with the liquid hydrocarbons, and will deposit less volatile ones which it may be holding in suspension, in order to saturate itself with the more volatile.

It is thus seen that with an ordinary coal gas these factors would limit the degree to which carburetting could be carried, and there are not wanting indications that the limit would soon be reached. If a gas contains the vapour of a hydrocarbon liquid under ordinary conditions, the vapour will have a tendency to deposit under the influence of either cold or pressure, an exposed pipe in cold weather causing serious deterioration to the illuminating value of coal gas. Some very valuable experiments made by Mr. C. E. Botley show that when coal gas is compressed under a pressure of $1\frac{1}{2}$ atmospheres, it loses about 17 per cent. of its illuminating power, and deposits about 5 oz. per 1,000 cubic feet of a liquid having a specific gravity of .870, and consisting largely of benzene and toluene. If, however, the gas is allowed to burn away, as the pressure falls so the illuminating power rises until, on reaching ordinary atmospheric pressure again, the gas has an illuminating power between 14 and 15 per cent. higher than the gas before compression, showing that the

liquid hydrocarbons deposited under pressure were again taken up as the pressure fell.

During the past few months the idea of the feasibility of carburetting coal gas in bulk has again been revived by the construction of an extremely ingenious apparatus, the outcome of the combined engineering skill and practical experience of Messrs. Maxim and Clark, which obviates to a great extent the difficulties which arise with the older forms of carburetter.

It has been shown that, when carburetting a gas with gasoline or a light naphtha spirit, the more volatile portion enriches the gas to an undue extent at first, and that, as the process continues, the amount taken up gets less and less. This would not so much matter in carburetting the gas in bulk, before it went into the holder, as it would become, to a great extent, mixed by diffusion, and a gas of fairly even illuminating power would result. But the Maxim-Clark apparatus is intended to not only do this, but also to carburet the gas used in large establishments and works; and it must, therefore, be so arranged as to supply each portion of gas passing through it with its own particular share of hydrocarbon, and not allow the selective absorption of the more volatile constituents by the first samples of gas.

For small installations, the apparatus consists of a circular copper retort, which is kept automatically filled to a fixed level from a reservoir outside the building filled with gasoline. The copper retort is jacketed, and steam or hot water is passed round it, which volatilises the gasoline; this passes over baffle plates in the top of the retort, and then through an automatic regulator into a small holder, which works like a gasometer, sealed in mercury. The gas to be carburetted has to pass through this holder, and as it does so, the gasoline vapour is supplied to it in the following way:—The holder works on a vertical spindle, which passes down the tube into the gasoline retort, and is so arranged that when the holder is grounded, *i.e.*, when no gas is passing through, the opening is closed, and no gasoline can pass into the holder. As gas is admitted, so the holder rises, and lifts the spindle with it, allowing the gasoline and vapour to push up through grooves cut in the bottom of it, which increase in size the higher the spindle is drawn, and so allow more gasoline to pass into the holder the more gas passes through.

It is found inadvisable to carburet a 16-candle gas higher than above 40-candle power, as up to this point it can be burnt from an

ordinary small burner consuming two cubic feet per hour. The gasoline used is light petroleum spirit, having a specific gravity of about '650; and experience shows that when ordinary 16-candle coal gas is carburetted, the illuminating power is raised one candle power for each pint per 1,000 cubic feet.

The apparatus I have just described, however, cannot be made on a sufficiently large scale to carburet gas in very great bulk; besides which, if a gas manager has a gasometer full of gas, the illuminating value of which is dangerously near the prescribed limit, it is evident that there is likely to be no room to mix in a sufficient quantity of the highly carburetted gas to bring up the illuminating power to the required standard, whilst, if there were room, diffusion would be so slow that practically the gases could not be given time to mix.

In order to obviate this trouble, Messrs. Maxim and Clark have devised an apparatus which will take a certain portion of gas out of the main, enrich it, and again return it to the main, and there mingling with the steady flow of gas, the whole becomes mixed. In this way, experiments made by Mr. Livesey, of the South Metropolitan Gas Company, show the system to be not only feasible but very convenient, and the ordinary coal gas, enriched to the extent of two candles, will retain the extra hydrocarbons perfectly well.

At the present time, the cost of enriching a 17-candle gas up to 18-candle, by the use of cannel coal, amounts to 2½d., whilst the cost of doing the same thing with gasoline would probably not exceed 1¾d.

From the earliest days of the gas industry attempts have been made to utilise tar for the production and enrichment of gas, and the patent literature of the century contains many hundreds of such schemes, most of which were stillborn, whilst a few spent a short and sickly existence, but none achieved success, and the reason of this it is not difficult to understand.

In order to make gas from tar two methods may be adopted:—(1) To condense the tar in the ordinary way, and afterwards to use the whole or portions of it for cracking into a permanent gas; or (2) to crack the tar vapours before condensation by passing the gas and vapours thorough superheaters.

If the first method be adopted, the trouble which presents itself, and in a few hours brings the apparatus to grief, is that tar contains 60 per cent. of pitch, which rapidly chokes and clogs up all the pipes; whilst if an

attempt is made to use a temperature at which the pitch is decomposed, then it is found that a non- or very poorly-luminous gas is the result, whilst a heavy deposit of carbon remains in the superheater or retort, and even at high temperatures easily-condensable vapours escape which afterwards create trouble in the pipes.

In order to get over the trouble arising from the choking by the pitch, attempts have been made to distil the tar at a low temperature, and utilise the 40 to 50 per cent. of oil so obtained for gasifying; but here the small yield of oil, and the expense of handling and distilling, have prevented tar from competing with coal as a source of gas.

A more economical way of doing this was to distil the tar so as to leave the pitch behind, and then instead of condensing the vapours to oil, to pass them through a heated chamber, which should convert them into permanent gases; but as soon as this was tried it was found that the lighter vapours, which distilled off first, only required a temperature to crack them which was totally inadequate to render the heavier vapours coming off later in the distillation permanent, so that they condensed to liquids; whilst if the heat was so arranged as to crack the heavy vapours, it broke up the lighter ones into gases of very poor illuminating power.

These troubles of course arise from the same cause, as in the earlier experiments on carburetting gas by passing over or through volatile naphthas—that is, that the tar, like the naphthas, is a mixture of many compounds varying in composition and properties.

In order to (as far as possible) get over this trouble, Mr. George Davis proposed in a paper read before the Society of Chemical Industry, to distil the tar, so as to remove pitch, and then to get rid of the naphthalene and anthracene, using the remainder, four-fifths of which can be gasified, for enriching the gas.

He calculates that coal yields 0.7 per cent. of its weight of tar, and that 0.42 of this is got rid of as pitch, whilst the remaining 0.28 per cent. can be converted into gas, a gallon of this oil yielding 80 cubic feet of 50-candle gas, and he infers from this that from a ton of ordinary coal, by utilising the tar in this way, 10,465 cubic feet of 18.4-candle gas could be obtained, instead of 10,000 of 17-candle gas. The success of such a process must, however, entirely depend upon the value of tar and the cost of cannel in any given locality, as the

expense of the process must of necessity be considerable.

The most successful attempt to utilise certain portions of the liquid products of distillation of coal is undoubtedly the Dinsmore process, in which the coal gas and the vapours which, if allowed to cool, would form tar, are made to pass through a heated chamber, and a certain proportion of otherwise condensable hydrocarbons are thus converted into permanent gases. Using a poor class of coal, it is claimed that 9,800 cubic feet of 20 to 21-candle gas can be made by this process; whilst, by the ordinary process, 9,000 cubic feet of 15-candle gas would have been produced.

In the centre of each bed of six retorts an empty retort, called the duct, is fixed; and through this the whole of the gas and vapour produced in the other retorts has to pass before reaching the hydraulic main. The duct is kept at a bright cherry red heat at the entrance (1,700° F., = 926° C.) and at a dull red at the exit end (1,200° F., = 639° C.), this gradation of heat being important, as, if it were at a high heat throughout, the hydrocarbons would be over-cracked, and a loss of illuminating power would be the result.

From the duct an ascension pipe leads the gas to the main by means of a bridge pipe, and this ascension pipe is provided with a water-jacket, which causes liquid tar to condense, and render any condensed pitch or carbonaceous matter sufficiently liquid to slide back down the pipe, and so prevent any chance of choking.

Each retort in the bench, besides having a connection with the duct, is also connected with the hydraulic main in the usual manner, but is closed by a heavy seal. One retort of the bed of six is drawn and charged hourly, and as each retort is heated for six hours, and as the products of distillation vary according to the period for which the retort has been heated, this arrangement keeps the average composition of the gases mingling in the duct fairly constant.

The quantity of tar produced by this process is roughly about two-thirds of the quantity made in the ordinary way, and is, moreover, very poor in light oils and tar acids, so that there can be but little doubt that the hydrocarbons and phenols are broken down into olefines and acetylenes.

An analysis of the Dinsmore gas shows the composition as—

Carbon dioxide	0.23
Illuminants	6.76
Carbon monoxide	8.10
Methane	40.34
Hydrogen	43.98
Nitrogen	0.59
	100.00
<hr/>	
Specific gravity	0.428
Illuminating power (candles) ..	22.3
Carbon density	2.95
Hydrogen density	5.80

In distilling the coal in the ordinary way, the yield of tar is 11 gallons per ton; but by the Dinsmore process only 7 gallons. On examining the analysis of the ordinary and Dinsmore tar, it is at once evident that the 4 gallons which have disappeared are the chief portions of the light oils and creosote oils; and these are the factors which have given the increase of illuminating power to the gas. As pointed out by Professor Foster, it is unfortunate that there are no figures to be obtained showing the differences in the gas and tar produced when the same coal is worked side by side by the ordinary and Dinsmore processes, as this would not only be of great scientific value, but would also clearly demonstrate the value of the process.

We must now consider the third method by which a poor coal gas can be carburetted—viz., by mixing it with oil gas obtained by cracking crude oils by heat. Experiments in this direction have lately been instituted—first by Mr. Good at Carshalton, and more recently by Mr. Herring at Dover. To carburet a gas directly by oil, the paraffin is injected into the retort under a slight pressure—not less than 15 lbs.—so that the oil is sprayed on to the red-hot coke, and cracking, yields oil gas, which mingles with the coal gas. In making a carburetted gas, it is far better to crack the liquid hydrocarbon in the presence of the diluents which are to mingle with it and act as its carrier; as, if this be done, a higher temperature can be employed, and more of the heavier portions of the oil converted into gas, without, at the same time, breaking down the gaseous hydrocarbons too much. For instance, if a petroleum oil is cracked by itself, the resulting gas would consist largely of hydrogen and methane, and the heavy hydrocarbons would probably vary from 16 to 26 per cent.—a considerable quantity of carbon separating; while if cracked in the presence of a stream of diluting gas, a far higher per-centage

of illuminants of the higher marsh gas series (ethane, &c.) would be produced, and a comparatively small quantity of hydrogen and methane. This is due to the same cause as the non-luminosity of the Bunsen burner—i.e., that when the hydrocarbons are undiluted, they can easily be broken down to hydrogen and carbon; whereas, when they are diluted, a far higher temperature is necessary to effect this action, and so the degradation of the hydrocarbons is stopped at an earlier stage.

In carburetting a poor coal gas with paraffin, it must be borne in mind that, as the coal is undergoing distillation, in the earlier stages a rich gas is given off, while towards the end of the operation, the gas is very poor in illuminants and rich in hydrogen; the methane disappearing with the other hydrocarbons, and the increase in hydrogen being very marked. Mr. Lewis T. Wright employed a coal requiring six hours for its distillation, and took samples of the gas at different periods of the time. On analysis, these yielded the following results:—

TIME AFTER COMMENCEMENT OF DISTILLATION.

	10 min.	1h. 30m.	3h. 25m.	5h. 35m.
Sulphuretted hydrogen ...	1'30	1'42	0'49	0'11
Carbon dioxide	2'21	2'09	1'49	1'50
Hydrogen	20 10	38'33	52'63	67'12
Carbon monoxide	6'19	5'68	6'21	6'12
Marsh gas	57'38	44'03	33'54	22'58
Illuminants	10'62	5'98	3'04	1'79
Nitrogen	2'20	2'47	2'55	0'78

This may be regarded as a fair example of the changes which take place in the quality of the gas during the distillation of the coal. In carburetting such a gas by injecting paraffin into the retort, it would be great waste to do so for the first two hours, as a rich gas is being given off which has not the power of carrying a very much larger quantity of hydrocarbons from being practically saturated with them. Consequently, to make it take along with it, in a condition not easily deposited, any further quantity, the paraffin would have to be broken down to a great extent; and the temperature necessary to do this would seriously affect the quality of the gas given off by the coal. When, however, the distillation had gone on for three hours, the rich portions of the coal gas would all have distilled off, and the temperature of the retort

would have reached its highest point; and this would be the time to feed in the oil, as its cracking being an exothermic action, the temperature in the retort would be increased, and the gas rich in hydrogen which was being evolved would carry with it the oil gas, and prevent any re-deposition.

In conclusion, it is unwise, in carburetted gas, to make a large quantity of a poor gas, and then expect to enrich it with a certain quantity of rich gas by allowing the two to mix in the holder, as, under these conditions, the mixing has to be done by the diffusion of gases, which takes place at a rate inversely proportional to the square root of their densities, with the result that a very heavy and a very light gas quickly mingle. Where, however, there is a rich gas with (say) a specific gravity of .516 and a poor one of .422, the difference in density is so slight that there is practically no tendency to mix; and the contents of the holder would remain in layers of the original gases, with thinner layers of mixed gases between them.

Miscellaneous.

INDIAN PRESERVES.

The demand for Indian preserves and jams has greatly increased during the past few years. In India preserves and jellies are made of the pear, quince, mango, tamarind, date, banana, guava, and other fruits. In Singapore pineapples are preserved whole, and in the Bahamas the manufacture is also carried on on a large scale, to the extent of nearly 1,000,000 cans annually. Each can of fruit, before the syrup is added, weighs 2 lbs. From 12,000 to 14,000 can be filled in a day, and 25,000 pines are usually consumed daily during the season. In Singapore much enterprise has been shown in preserving tropical fruits. There are two or three firms who deal largely in them.

The Indian preserves were formerly much in request. Thus, in the 13th century the most renowned preserve was a paste made of candied ginger. Among other fruits, &c., preserved in their natural state, in syrup, crystallised with sugar, or made into jelly, are the pineapple, bread-fruit, ginger, jack-fruit, the papaw, mangosteen, pomeloe, guava, and nutmeg. Although in flavour and preparation these preserves may not equal those of Europe, they make an agreeable change.

Pineapples.—The pineapple is one of the best of tropical fruits, although it is produced of a superior

quality by European cultivators. Its sweet and acid flavour, and pleasant aroma, make it sought after by consumers of all classes. One house in Singapore ships about 70,000 tins of this fruit. Pineapple marmalade (thought by some to be the most delicious preserve in the world) might also be sold at 5d. per pound in London.

Guava Jelly.—There are two species of guava fruit, the red guava, and the white, or Peruvian guava. Both make excellent sweetmeat paste or jelly, which is very pleasant and nutritious, from its superior power of assimilation with the gastric juice, and perfect development of saccharine.

It is said that a hundred different preserves could be made from a judicious blending of the fruits of the East and West Indies and South America.

The jamun (*Syzygium jambolanum*), a sort of long, dark, purple plum, the size of a large date, makes excellent preserves, and has exactly the flavour of black-currant jelly, to simulate which large quantities are sent from India to England. It is also used for flavouring other jams.

The fruits of *Inocarpus edulis* are preserved in the Indian Archipelago. A sweet conserve is made in India of the fruits of *Terminalia Chebula*. Another is made of the fruits of *Phyllanthus distichus*, at Birbhum in Bengal. The acid calyces of the rosella (*Hibiscus sabdariffa*) are converted into an excellent jelly, which would be highly appreciated in England, if once introduced. Jam and jelly are made in Canada from the fruit of *Shepherdia argentea*.

The fruit of *Spondias*, not unlike a cherry, is made into jelly. The scarlet fruit of the quandong (*Fusanus acuminatus*), the size of a small peach, makes an excellent preserve for tarts in Australia.

The tamarind plum (*Dialium indum*) of Java has a pod filled with a delicate, agreeable pulp, much less acid than the tamarind. The golden drupes of *Spondias cytherea*, or *dulcis*, a native of the Society Islands, are compared, for flavour and fragrance, to the pineapple. The large acid fruits of the kai apple (*Aberia caffra*) of Natal can be converted into a good preserve of the red-currant jelly class. The fruit of *Cornea speciosa* is delicious; it is called "mangaba" by the Brazilians, and when ripe is brought in great quantities to Pernambuco for sale.

The fruit of the goudi, of Japan (*Elæagnus edulis*), makes excellent preserves, fruit syrups, and tarts. The berries of *Pyrus aucuparia*, and of *P. baccata* are made into comfits, conserves, and compôtes. The fruits of *Astrocaryum ayri*, of Brazil, are made into an excellent preserve, which is much esteemed in that country.

The fruit of the Chinese quince (*Diospyros amara*) is converted into sweetmeats, of which the Chinese are exceedingly fond.

The bread fruit, in syrup or crystallised, may please native palates, but it is not likely to find favour in Europe, being flavourless, and more of a food substance than a fruit.

Preserved ginger is popular in England, but is not much esteemed on the Continent. The Spaniards eat raw ginger in the morning, to give them an appetite; and it is used at table fresh or candied. Among sailors it is considered antiscorbutic. The quantity of preserved ginger imported ranges annually from 1,500 to 2,500 cwt., value £3,500 to £4,300. It forms the bulk of the succades received from the Chinese Empire, 18,000 to 20,000 cwt. coming from Hong Kong. Some ginger is also received from India. The mode of preparing it in the East is as follows:—The racemes are steeped in vats of water for four days, changing the water once. After being taken out, spread on a table, and well pricked or pierced with bodkins, they are boiled in a copper cauldron. They are then steeped for two days and nights in a vat with a mixture of water and rice flour. After this they are washed with a solution of shell lime in a trough, then boiled with an equal weight of sugar, and a little white of egg is added to clarify. The ginger, candied or dried in sugar, is shipped in small squares of zinc. That preserved in syrup, is sent out in jars of glazed porcelain of 6 and 3 lbs., and packed in cases of six jars. The quality called “mandarin” is put up in barrels.

The *papaw* (*Carica papaya*) is a fleshy, pulpy fruit, of an orange colour, sweet and refreshing, which is eaten as the melon is in Europe. This fruit, however, in syrup or crystallised, has very much the taste of a turnip.

The *mangosteen* is a fruit about the size of a mandarin orange, of a sweet flavour, accompanied with a slight acidity, and an odour resembling the raspberry. It is the produce of *Garcinia mangostana*, and is one of the most delicious and famous of the fruits of the Indian Archipelago, ranking with the pineapple. Presents of baskets of it are sent from Singapore to India and China. It is a pleasant fruit, with a delicate but characteristic flavour, partaking of the strawberry, grape, pine-apple, and peach. The happy mixture of tart and sweet in the pulp renders it no less salutary than pleasant; and it is the only fruit which sick people are allowed to eat without scruple. In Cochin China they sell at 4s. to 5s. the 100.

The *pomalo* (*Citrus decumana*) is a large fruit of the orange family, with an acid flavour, frequently bitter. The pulp and thick rind, crystallised with sugar, are eatable, but lose much of their natural flavour. It is better known as the shaddock; and the fruit will exceptionally attain a weight of 20 pounds.

The *Mammea Apple* (*Mammea Americana*) is abundant in the West Indies. The pulp is of a sweet, aromatic smell, and of a peculiar, yet delicious flavour. It is sometimes sliced and eaten with sugar or wine, and also makes a very good jam, by being preserved in sugar. Another tropical fruit, the *Mammea sapota*, is known as American marmalade, from the similarity of the flavour of the pulp to the marmalade made from quinces.

The succulent fruits of *Cicca disticha* have an acid sweet flavour, and are eaten cooked, or made into preserve.

The green, fleshy, gratefully acid fruits of *Averrhoa Bilimbe* and *A. Carambola* are preserved, and used for tarts, and for flavouring various dishes.

The *Comquat*, or *Kumquat* (*Citrus japonica*). An excellent preserve, is made from the sweet peel and acid pulp of this curious, small nutmeg-shaped orange in China and Japan.

The red berries of *Carissa carandas* furnish a well-known substitute for red currant jelly, in India and China.

The Peruvian *cherimoyer* (*Anona cherimolia*) is a highly esteemed succulent fruit, of a most luscious flavour, containing a soft sweet mucilage, resembling strawberries and cream. It is often called the “Queen of Fruits.”

The mango, the mangosteen, the custard-apple, and the durian, are known by repute only to the people of this country; but while they might easily be frozen and brought here in admirable condition—dishes fit for the gods—no attempt is made to utilise these luscious fruits of India in their fresh state, nor is very much done in preserving them.

The durian (*Durio zibethinus*), although it has a strong offensive smell, is eaten greedily by the Burmese, and as many as 40,000 are annually sent to Upper Burma.

The mango (*Mangifera indica*) is the best fruit in India, as highly-valued as the peach with us, and forms a considerable portion of the food of large classes of the native inhabitants. The varieties cultivated are about as numerous as are those of the apple. An Indian gentleman has made coloured illustrations of more than 200 varieties of this fruit. The quality is difficult to judge of from external appearance. There are large and small, elongated and abbreviated, bright orange-coloured and green. They vary much in taste, some being of the flavour of honey, some of pineapple, some of orange, while others have distinct flavours of their own. A good mango should be as little stringy as possible, and should not have too much of the turpentine flavour towards where it is attached to the foot-stalk; a moderately aromatic savour there is by no means objectionable.

The young unripe fruit are largely consumed in India in tarts, &c., and mango-fool there takes the place of gooseberry fool. The half-ripe fruits are also made into a marmalade which resembles much that of apples.

So large is the consumption of this fruit in India that waggon loads, bringing collectively twenty tons of the fruit, have entered the island of Bombay in a single day. The fruit of the finest mangoes have a rich, sweet-perfumed flavour, accompanied by a grateful acidity.

The thick juice is by the natives of India squeezed out, spread on plates, and allowed to dry, in order to form the thin cakes known as *amsatta*. The green

fruit is sliced and cooked in curry; is made into pickle with salt, mustard, oil, and chillies; and also into preserves and jams by being boiled and cooked in syrup. Some varieties of mango have fruits as big as an infant's head, ovate, with a golden skin, speckled with carmine, and a greengage flavour.

The finest varieties of this almost unequalled fruit seem to thrive in Jamaica (where it was introduced about a century ago), as well as in Bombay. It is the popular fruit there with the negroes.

The Siam mango is a tolerable kind, which sometimes grows to one pound weight. The egg-mango is a small, yellow kind, with too much of the turpentine flavour, and too acidulous to be much prized. The horse-mango is a very coarse fruit of unpleasant odour, much eaten by the lower classes, and producing cholera, diarrhoea, and dysentery. The Bombay mango, termed "Parsee," is known for its lusciousness and delicacy of flavour, the absence of fibre, firmness of flesh, thinness of skin, and small size of the stone. It must, however, be admitted that on tasting this delicious fruit for the first time, a slight turpentine flavour is experienced.

A raw guava, or even a raw mango, may not be, to every Englishman's palate, a satisfactory exchange for a mellow pear or a juicy peach, but preserved mango and guava jelly are things by no means to be despised. Some of these preserved foreign fruits are delicacies only to be obtained at some of the best West-end houses, at prices too high for ordinary consumers; but if large quantities were sent into the market, and the prices consequently lowered, the demand would become greater, and the sale more profitable, and would probably lead to the introduction of new articles, to the mutual benefit both of ourselves and the growers and preservers of the fruits.

Mango jam is prepared by boiling the mango in syrup, after removing the skins and stones, and the sour juice squeezed out by the free use of forks, and soaking in fresh water. Two pounds of mango to one pound of sugar is the proportion in which it is prepared.

Bilimbi jam is made by removing nearly three-fourths of the juice of the fruits of *Averthoa bilimbi*, and soaking in water, squeezing the fruit and boiling them in syrup. Nelli jam, from the fruit of *Phyllanthus embelica*, is made in the same manner; proportion of fruit and sugar same as mango.

From Natal, there have been shown at the various exhibitions, Amatungula jam, the produce of the fruit of *Arduina grandiflora*, sometimes called the Natal plum. This jam is firm, nearly like that of the quince, and has a rough acid flavour; but is a curious and agreeable preserve.

The gooseberry jelly from there is the produce of *Physalis pubescens*. It is pleasantly sharp, without having the rough, metal-like acid of the amatungula. The guava jelly has the full taste of the West Indian preserve. The pineapple jam has the rick, almost too-luscious, taste for which the Natal pines are famed. The loquat is a very sweet and fine pre-

serve, slightly resembling quince marmalade, but with less pronounced individual flavour. The fruit is very delicious in its unpreserved ripe state, having the flavour of an apple grafted upon the flesh of the melting peach, with large apple pips taking the place of the stone, and ripening in massive bunches. Like the peach, the fruit is almost too delicate for a preserve. Its most refined and exquisite qualities do not survive the bath of boiling sugar. The rosella is the preserved fruits or calyces of the *Hibiscus sabdariffa*, which makes a most estimable substitute for red currant jelly, particularly relished in hot climates. The grenadilla, the purple fruit of a passion-flower (*Passiflora edulis*), is almost without a rival for delicate fragrance and perfume, has a sweetish acid taste, and makes an excellent preserve. The St. Helena peach resembles, in the preserved state, a very excellent yellow plum. The shaddock marmalade might also be spoken of as a worthy substitute for the Seville orange marmalade.

Notes on Books.

EUCLID'S ELEMENTS OF GEOMETRY. By A. E. Layng, M.A. London: Blackie and Son. 1890.

This edition of Euclid contains the first four books, book six and parts of books five and seven. In addition to the text, notes and exercises are appended to the propositions to which they refer, and worked-out examples are given at intervals as models. At the end of each book additional propositions are given, together with miscellaneous exercises. In the diagrams an attempt has been made to give greater clearness and simplicity by the use of lines of various thicknesses. An appendix contains a selection of recent examination papers, an explanation of a few typical geometrical theorems, and some alternative proofs of certain of the propositions.

General Notes.

GERMAN TECHNICAL MUSEUMS.—The lately issued volume of the "Transactions of the Royal Institute of Architects" (new series, vol. 6), contains a paper by Mr. Frank Granger on this subject, which contains the results of a tour of six weeks, occupied in visiting the technical museums and schools of North Germany. The places visited include Hamburg, Berlin, Dresden, Chemnitz, Leipzig, and Hanover. Several of these institutions were described by Professor Percy Frankland, in his paper on "The Aim and Scope of Higher Technical Education." (See *Journal*, vol. xxxviii., p. 599.)

CHICAGO EXHIBITION, 1893.—A Reuter's telegram announces that President Harrison has issued a proclamation declaring that satisfactory proof has been presented to him that adequate grounds, buildings, and funds have been provided at Chicago for the Columbian Exhibition; and he therefore declares that it will be opened on May 1st, 1893, and will not close before the last Thursday in the October following. The President, in the name of the Government and people of the United States, invites all the nations of the earth to take part in the commemoration of an event pre-eminent in human history, and of lasting interest to mankind, by appointing representatives at the Exhibition, and by sending such exhibits as may most fitly and fully illustrate their resources and industries, and the progress of civilisation.

CONGRESS OF HYGIENE.—A letter has been published, which is signed by the Duke of Westminster, Sir Andrew Clark, Mr. Thomas Bryant, President of the Royal College of Surgeons; the Earl of Ravensworth, President of the Royal Agricultural Society; Mr. Alfred Waterhouse, R.A., President of the Royal Institute of British Architects; Dr. F. J. Mouat; Sir John Coode, President of the Institution of Civil Engineers; Sir James Paget, Sir Spencer Wells, and Sir Douglas Galton, drawing attention to the Seventh International Congress of Hygiene and Demography, to be held this year in London. The Prince of Wales, as President, has signified his intention of opening it on Monday, the 10th August; and the Congress will conclude its Session on the 25th of that month. The Congress is intended to promote the interchange of knowledge between those persons in different countries interested in the study of hygiene and demography. Among the subjects proposed for discussion are—The prevention of communicable diseases, the science of bacteriology in relation to communicable diseases; industrial questions, as, for instance, the regulation of industrial occupations from a health point of view, including the hours of labour and the influence of dwellings upon labour; the hygiene of infancy and childhood; the hygiene of houses and towns, including questions of width of streets, height of buildings, and disposal of the dead; and the duty of the Government towards the nation in regard to health, and the machinery necessary for exercising that duty; the laws for notification and isolation of disease; the status and education of medical officers of health, and of sanitary inspectors. The Lord Mayor and Corporation of the City will receive the large number of foreign members who are expected to be present, and the discussions will be carried on in the meeting-rooms of the learned societies in Burlington-house. The donations already received amount to £1,100. The bankers, who will receive subscriptions, are Sir Samuel Scott & Co., 1, Cavendish-square, and Messrs. Dimsdale, Fowler & Co., 50, Cornhill. The honorary secretaries are Dr. W. H. Corfield and Dr. G. V. Poore, of 20, Hanover-square.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

JANUARY 14.—J. F. GREEN, "Steam Lifeboats." PROFESSOR ELGAR will preside.

JANUARY 21.—A. G. GREEN, C. F. CROSS, and E. J. BEVAN, "Photography in Aniline Colours." CAPT. ABNEY, C.B., F.R.S., will preside.

JANUARY 28.—CARMICHAEL THOMAS, "Illustrated Journalism." LUKE FILDES, R.A., will preside.

FEBRUARY 4.—T. EMERSON DOWSON, "The Growing Need for Decimal Coinage, Weights, and Measures." SIR HENRY E. ROSCOE, M.P., F.R.S., will preside.

FEBRUARY 11.—SIR ROPER LETHBRIDGE, M.P., "The Proposed Irish Channel Tunnel."

Papers for which no dates have as yet been fixed:—

"The Sources of Petroleum." By WM. TOPLEY, F.R.S.

"Methods and Processes of the Ordnance Survey." By COLONEL SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S.

"Colonisation and its Limitations." By E. J. RAVENSTEIN.

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"The Use of Petroleum in Prime Motors." By WILLIAM ROBINSON.

"Electricity in relation to the Human Body." By H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D.

"Milling Machinery." By J. HARRISON CARTER.

"Harbours, Natural and Artificial." By F. H. CHEESWRIGHT.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock:—

JANUARY 20.—WILLIAM H. WYLDE, C.M.G., "The Opening of Africa."

FEBRUARY 17.—COMMANDER V. LOVETT CAMERON, C.B., "Chartered Companies in Africa."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Papers for which dates are not yet fixed:—

C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

LEWIS ATKINSON, "The Diamond Fields of South Africa."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

JANUARY 22.—EDWARD J. WATHERSTON, "Hall-marking of Silver Plate, with special reference to India." SIR THEODORE CRACRAFT HOPE, K.C.S.I., C.I.E., will preside.

FEBRUARY 26.—ROBERT GORDON, M.Inst.C.E., "The Economic Development of Siam." SIR CHARLES EDWARD BERNARD, K.C.S.I., will preside.

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. the LORD REAY, G.C.S.I., G.C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

JANUARY 27.—WILLIAM SIMPSON, "Lithography: a finished chapter of Illustrative Art." SIR JAMES D. LINTON, P.R.I., will preside.

FEBRUARY 10.—HEYWOOD SUMNER, "Sgraffito." CHARLES BARRY, F.R.I.B.A., will preside.

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

CANTOR LECTURES.

The following Courses of Cantor Lectures will be delivered on Monday evenings at Eight o'clock :—

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

January 26; February 2, 9.

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

February 16, 23; March 2.

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

March 9, 16, 23.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 12...Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m.

Mr. Shelford Bidwell, "Light and Electricity."

TUESDAY, JAN. 13...Royal Society of Antiquaries of Ireland, Royal Dublin Society's House, Kildare-street, Dublin, 4 p.m. Annual General Meeting. 1. Mr. Thomas Drew, "A Map of the Surroundings of the Cathedral Church of St. Patrick de Insula, Dublin, in and previous to the 18th Century." 2. Mr. Henry F. Berry, "The Water Supply of Ancient Dublin." 3. Very Rev. Canon Edmond

Barry, "Some Ogham Inscriptions recently discovered at Ballyknock, in the Barony of Kintaloon, County Cork." 4. Mr. G. D. Burtchell, "The Geraldines of County Kilkenny." 5. Lord Walter Fitz Gerald, "Description of the Stone-roofed Building called St. Patrick's Chapel, at Ardross, in the County Kildare." 6. Mr. James Mills, "House-keeping in Mediæval Dublin, as illustrated by the Account Rolls of the Priory of the Holy Trinity." 7. Mr. T. J. Westropp, "The Normans in Thomond" (concluded).

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. W. H. Allen, "Auxiliary Engines in connection with the Modern Marine-Engine."

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. E. H. Maunder, "Photography as applied to Astronomy."

Astronomical, 3, Hanover-square, W., 8½ p.m. 1. Messrs. J. Edge Partington and Charles Heape, Exhibition of an Ethnographical Album of the Pacific Islands. 2. F. W. Rudler, "The Source of the Jade used for Ancient Implements in Europe and America."

Biblical Archaeology, 9, Conduit-street, W., 8 p.m. Anniversary Meeting.

Colonial Institute, Whitehall Rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Mr. Henry F. Moore, "Agricultural and Technical Education in the Colonies."

WEDNESDAY, JAN. 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. F. Green, "Steam Lifeboats."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, JAN. 15...Royal, Burlington-house, W., 4½ p.m. Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. P. H. Carpenter, "Certain Points in the Morphology of the Cystidea." 2. Mr. Thomas Kirk, "A Botanical Visit to the Auckland Isles."

Chemical, Burlington-house, 8 p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. H. Cummings, "The British Orpheus, Henry Purcell."

Society for the Encouragement of Fine Arts. Conversation at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly, W., 8 p.m.

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Inaugural Address by the President, Mr. W. Crookes.

Historical, 11, Chandos-street, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, JAN. 16...Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. R. G. Hansford Worth, "A Survey of the Bed of Sutton Pool, Plymouth."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

New Shakspeare, University College, W.C., 8 p.m. A paper by Mr. A. H. Rullen.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. Minchin, "Photo-Electricity."

2. Prof. Barrett, "A Lecture-room Method of determining 'g.'" 3. Sir John Conroy, "The Change in the Absorption Spectrum of Cobalt Glass produced by Heat."

United Service Institution, Whitehall-yard, 3 p.m. Mr. C. W. Smith, "Steel, as Applied to Armour Plates."

Journal of the Society of Arts.

No. 1,991. VOL. XXXIX.

FRIDAY, JANUARY 16, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

FOREIGN & COLONIAL SECTION.

The meeting of this Section, announced for Tuesday, 20th inst., is postponed, as Mr. W. H. Wylde, C.M.G., who was to have read a paper on "The Opening of Africa," is prevented by illness from fulfilling his engagement.

EXAMINATION PRIZES.

The Council of the Society have determined to offer the following prizes, in connection with the Society's Examinations for the year 1891, out of the funds which have been placed at their disposal for the purpose by the Worshipful Companies of Goldsmiths, Mercers, Salters, and Skinners:—A first prize of £3, and a second prize of £2, in each of the following subjects: English, Commercial Geography, French, German, and Portuguese.

The prizes will only be awarded to candidates who have taken first-class certificates, and are certified as proficient by the examiner in each subject.

In addition to the above prizes, the Cloth-workers' Company offer first, second, and third prizes, of £5, £3, and £2 respectively, to candidates obtaining a first-class certificate in Italian or in Spanish.

The above prizes are additional to the Bronze Medals, which will be awarded to the candidates obtaining the highest number of marks in the first-class of each subject, under the conditions stated in the Programme of Examinations.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

GASEOUS ILLUMINANTS.

BY PROF. VIVIAN B. LEWES.

Lecture IV.—Delivered December 15, 1890.

Mr. Frank Livesey, in the concluding sentence of a paper read before the Southern District Association of Gas Managers and Engineers during the past month, on "A Ready Means of Enriching Coal Gas," speaking of enrichment by gasolene by the Maxim-Clarke process, said "it should, in many cases, take the place of cannel, to be replaced in its turn, probably, by a water gas carburetted to 20 or 25-candle power." And now, having fully reviewed the methods either in use or proposed for the enrichment of gas, we will pass on to this, the probable cannel of the future.

Discovered by Fontana, in 1780, and first worked by Ibbetson, in England, in 1824, water gas has added a voluminous chapter to the patent records of England, France, and America, no less than sixty patents being taken out between 1824 and 1858, in which the action of steam on incandescent carbon was the basis for the production of an inflammable gas.

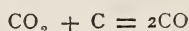
Up to the latter date the attempts to make and utilise water gas all met with failure; but about this time the subject began to be taken up in America, and the principle of the regenerator, enunciated by Siemens in 1856, having been pressed into service in the water-gas generator under the name of fixing chambers or superheaters, we find water gas gradually approaching the successful development to which it has attained in the United States during the last ten years. Having now, by the aid of American skill, been brought into practical form, it is once more attempting to gain a foothold in Western Europe—the land of its birth.

When carbon is acted upon at high temperatures by steam, the first action which takes place is the decomposition of the water vapour, the hydrogen being liberated, whilst the oxygen unites with the carbon to form carbon dioxide:—

Carbon. Water.



And the carbon dioxide so produced interacts with more red-hot carbon forming the lower oxide—carbon monoxide:—



So that the completed reaction may be looked upon as yielding a mixture of equal volumes of hydrogen and carbon monoxide, both of them inflammable but non-luminous flames. This decomposition, however, is rarely completed, and a certain proportion of carbon dioxide is invariably to be found in the water gas, which, in practice, generally consists of a mixture of about this composition:—

WATER GAS.

Hydrogen	48.31
Carbon monoxide	35.93
Carbon dioxide	4.25
Nitrogen	8.75
Methane	1.05
Sulphuretted hydrogen	1.20
Oxygen	0.51
	100.00

The above is an analysis of water gas made from ordinary gas coke in a Van Steenberg generator.

The ratio of carbon monoxide and carbon dioxide present entirely depends upon the temperature of the generator, and the kind of carbonaceous matter employed. With a hard, dense anthracite coal, for instance, it is quite possible to attain a temperature at which there is practically no carbon dioxide produced, whilst with an ordinary form of generator and a loose fuel like coke, a large proportion of carbon dioxide is generally to be found.

The sulphuretted hydrogen in the analysis quoted is, of course, due to the high amount of sulphur to be found in the gas coke, and is practically absent from water gas made with anthracite, whilst the nitrogen is due to the method of manufacture, the coke being, in the first instance, raised to incandescence by an air-blast, which leaves the generator and pipes full of a mixture of nitrogen and carbon monoxide (producer gas), which is carried over by the first portions of water gas into the holder. The water gas so made has no photometric value, its constituents being perfectly non-luminous, and attempts to use it as an illuminant have all taken the form of incandescent burners, in which thin mantles or combs of highly refractory metallic oxides have been heated to incandescence. In carburetted water gas this gas is only used as the carrier of illuminating

hydrocarbon gases, made by decomposing various grades of hydrocarbon oils into permanent gases by heat.

Many forms of generator have been used in the United States for the production of water gas, which, after or during manufacture, is mixed with the vapours and permanent gases obtained by cracking various grades of paraffin oil, and "fixing" them by subjecting them to a high temperature; and in considering the subject of enrichment of coal gas by carburetted water gas, I shall be forced, by the limited time at my disposal, to confine myself to the most successful of these processes, or those which are already undergoing trial in this country.

In considering these methods, we find they can be divided into two classes:—

1. Continuous processes, in which the heat necessary to bring about the interaction of the carbon and steam is obtained by performing the operation in retorts externally heated in a furnace; and

2. Intermittent processes, in which carbon is first heated to incandescence by an air-blast, and then, the air-blast being cut off, superheated steam is blown in until the temperature is reduced to a point at which the carbon begins to fail in its action, when the air is again admitted to bring the fuel up to the required temperature, the process consisting of alternate formation of producer gas with rise of temperature, and of water gas with lowering of the temperature.

Of the first class of generator, none, as far as I know, have as yet been practically successful, the nearest approach to this system being the "Meeze," in which fire-clay retorts in an ordinary setting are employed. In the centre of each retort is a pipe leading nearly to the rear end of the retort, and containing baffle plates. Through this a jet of superheated steam and hydrocarbon vapour is injected, and the mixture passes the length of the inner tube, and then back through the retort itself—which is also fitted with baffle plates—to the front of the retort, whence the fixed gases escape by the stand-pipe to the hydraulic main, and the rich gas thus formed is used either to enrich coal gas, or is mixed with water gas made in a separate generator. In some forms the water gas is passed with the oil through the retort. In such a process, the complete breaking down of some of the heavy hydrocarbons takes place, and superheated steam, acting on the carbon so liberated, forms water gas which bears the


lower hydrocarbons formed with it; but inasmuch as oil is not an economical source of carbon for the production of water gas, this would probably make the cost of production higher than necessary. This system has been extensively tried, and indeed used to a certain extent, but the results have not been altogether satisfactory, one of the troubles which have had to be contended with being choking of the retorts.

Of the intermittent processes, the one most in use in America is the "Lowe," in which the coke or anthracite is heated to incandescence in a generator lined with fire-brick, by an air-blast, the heated products of combustion as they leave the generator and enter the superheaters being supplied with more air, which causes the combustion of the carbon monoxide present in the producer gas, and heats up the fire-brick "baffles" with which the superheater is filled. When the necessary temperature of fuel and superheater has been reached, the air-blasts are cut off, and steam is blown through the generator, forming water gas, which meets the enriching oil at the top of the first superheater, called the "carburetter," and carries the vapours with it through the main superheater, where the "fixing" of the hydrocarbons takes place.

The chief advantage of this apparatus is that the enormous superheating space enables a lower temperature to be used for the "fixing." This does away, to a certain extent, with the too great breaking down of the hydrocarbons, and consequent deposition of carbon. This form of apparatus has just found its way to this country, and I describe it as being the one most used in the States, and the type upon which, practically, all water-gas plant with superheaters has been founded.

The Springer apparatus, which is under trial by one of the large gas companies, differs from the Lowe merely in construction. In this apparatus the superheater is directly above the generator; and there is only one superheating chamber instead of two. The air-blast is admitted at the bottom, and the producer gases heat the superheater in the usual way; and when the required temperature is reached, the steam is blown in at the top of the generator, and is made to pass through the incandescent fuel, the water gas being led from the bottom of the apparatus to the top, where it enters at the summit of the superheater, meets the oil, and passes down with it through the chamber, the finished gas escaping at the middle of the apparatus.

This same idea of making the air-blast pass up through the fuel, whilst in the subsequent operation the steam passes down, is also to be found in the Loomis plant, and is a distinct advantage, as the fuel is at its hottest where the blast has entered; and, in order to keep down the per-centage of carbon dioxide, it is important that the fuel through which the water gas last passes should be as hot as possible, to insure its reduction to carbon monoxide.

The Flannery apparatus is again but a slight modification of the Lowe plant, the chief difference being that, as the gas leaves the generator, the oil is fed into it, and, with the gas, passes through a -shaped retort tube, which is arranged round three sides of the top of the generator; and in this the oil is volatilised, and passes, with the gas, to the bottom of the superheater, in which the vapours are converted into permanent gases.

The Van Steenberg plant, with which I have been experimenting for some time, stands apart from all other forms of carburetted water-gas plant in that the upper layer of the fuel itself forms the superheater, and that no second part of any kind is needed for the fixation of the hydrocarbons, an arrangement which reduces the apparatus to the simplest form, and leaves no part which can choke or get out of order, an advantage which will not be underrated by anyone who has had experience of these plants. Whilst, however, this enormous advantage is gained, there is also the drawback that the apparatus is not fitted for use with crude oils of heavy specific gravity, such as can be dealt with in the big external superheaters of the Lowe class of water-gas plant, but the lighter grades of oil must be used in it for carburetting purposes.

I am not sure in my own mind that this, which appears at first sight a disadvantage, is altogether one, as, in the first place, the lighter grades of oil, if judged by the amount of carburetting power which they have, are cheaper per candle power, added to the gas, than the crude oils, whilst their use entirely does away with the formation of pitch and carbon in the pipes and purifying apparatus—a factor of the greatest importance to the gas manufacturer.

The fact that light oils give a higher carburation per gallon than heavy crude oil, is due to the fact that the latter have to be heated to a higher temperature to convert them into permanent gas, and this causes an

over-cracking of the most valuable illuminating constituents; and this trouble cannot be avoided, as, if a lower temperature is employed, easily condensable vapours are the result, which, by their condensation in the pipes, give rise to much trouble.

The simplicity of the apparatus is a factor which causes a great saving of time and expense, as it reduces to a minimum the risk of stoppages for repairs, whilst the initial cost of the apparatus is, of course, low, and the expense of keeping in order practically *nil*.

When I first made the acquaintance of this form of plant, a few years ago, the promoters were confident that nothing could be used in it but American anthracite, of the kind they had been in the habit of using in America, and a light naphtha of about 0.689 specific gravity, known commercially as 76° Beaumé.

A few weeks' work with the apparatus, however, quickly showed that, with a slightly increased blow, and a rather higher column

of fuel gas coke could be used just as well as anthracite, and that by increasing the column of fuel, a lower grade of oil could be employed; so that, during a considerable portion of the experimental work, nothing but gas coke from the Horseferry-road Works, and a petroleum of a specific gravity of about .709 was employed.

Having had control of the apparatus for several months, and, with the aid of a reliable assistant, having checked everything that went in and came out of the generator, I am in a position to state authoritatively that, using ordinary gas coke and a petroleum of specific gravity, ranging from 0.689 to 0.709, 1,000 cubic feet of gas, having an illuminating power of 22 candles, can be made with an expenditure of 28 to 32 lbs. of coke and 2½ gallons of petroleum. The most important factors, *i.e.*, the quantity of petroleum and the illuminating value of the gas have also been checked and corroborated by Mr. Heisch and Mr. Leicester Greville.

Total gas made = 8,700 cubic feet.

Time taken..	{ Blowing	One hour.
	{ Making	Fifty minutes.
Fuel used ..	{ Gas coke	270 lbs. = 31 lbs. per 1,000 c.f.
	{ Naphtha, sp. grav. .709	34 gals. = 27 gals. ,, ,,
Illuminating power of gas = 21.9 candles.		

I must admit that these results far exceeded my expectations, although they only confirmed the figures claimed by the patentee; and there are not wanting indications that, when worked on a large scale and continuously, they might be even still further lowered, as it is impossible to obtain the most economical results when making less than 10,000 cubic feet of the gas, as the proper temperature of the walls of the generator are not obtained until after several makes; and it is only after about 8,000 cubic feet of gas has been made that the best conditions are fulfilled.

It will enable a sounder judgment to be formed of the working of the process if the complete experimental figures for a make of gas be taken.

1st. make.—Gas produced = 3,600 cubic feet.	.....	Naphtha used = 10	7
2nd. ,, ,, ,, = 2,800 ,,	.....	,, ,, =	7 6
3rd. ,, ,, ,, = 2,300 ,,	.....	,, ,, =	5 3
8,700		24 0	

COMPOSITION OF THE GAS.

Hydrogen	46.75
Olefines	7.59
Ethane	6.82
Methane	11.27
Carbon monoxide	11.65
Carbon dioxide	0.50
Oxygen	0.17
Nitrogen	8.25

100.00

UNPURIFIED GAS CONTAINED

Carbon dioxide	2.32 per cent.
Sulphuretted hydrogen	2.84 ,,
Total sulphur per 100 cubic ft. =	6.67
Ammonia	Nil.
Bisulphide of carbon	Nil.

The last portion of the Table shows the economy which arises as the whole apparatus gets properly heated. Thus the first make used 3 gallons naphtha, per 1,000 cubic feet;

the second 2 gallons 6 pints per 1,000 cubic feet; and the third 2 gallons 4 pints per 1,000 cubic feet; and it is therefore not unreasonable to suppose that in a continuous make

these figures could be kept up, if not actually reduced still lower.

In introducing the oil it is not injected, but is simply allowed to flow in by gravity, at a point about half-way up the column of fuel, the taps for its admission being placed at intervals round the circumference of the generator, and the oil at first begins to flow down the inside wall of the generator, but being vapourised by the heat, the vapour is borne up by the rush of steam and water gas, and is cracked to a permanent gas in the upper layer of fuel. This I think is the secret of not being able to use heavier grades of oil, these being sufficiently non-volatile to trickle down the side into the fire-box at the bottom, and so to escape volatilisation. I have tried to steam-inject the oil, but have not found that it yields any better results.

One of the first things that strikes anyone on seeing a make of gas by this system is the enormous rapidity of generation. Mr. Leicester Greville, who is chemist to the Commercial Gas Company, in reporting on the process, says, "The make of gas was at the rate of about 86,000 cubic feet in 24 hours. A remarkable result, taking into consideration the size of the apparatus." It is quite possible, with the small apparatus, to make 100,000 cubic feet in 24 hours; indeed, the run for which the figures are given are over this estimate; and it must be borne in mind that this rapidity of make gives the gas manager complete control over any such sudden strains as result from fog or other unexpected demands on the gas-producing power of his works; whilst a still more important point is, that it does away with the necessity of keeping an enormous bulk of gas ready to meet any such emergency, and so renders unnecessary the enormous gasholders, which add so much to the expense of a works, and take up so much room.

Perhaps the greatest objection to water gas in the public mind is the dread of its poisonous properties, due to the carbon monoxide which it contains; but if we come to consider the evidence before us on the increase of accidents due to this cause, we are struck by the poor case which the opponents of water gas are able to make out. No one can for a moment doubt the fact that carbon monoxide is one of the deadliest of poisons. It acts by diffusing through the air cells of the lungs, and forming, with the colouring matter of the blood corpuscles, a definite compound, which prevents them carrying on their normal function of taking up

oxygen and distributing it throughout the body, to carry on that marvellous process of slow combustion, which not only gives warmth to the body, but also removes the waste tissue used up by every action, be it voluntary or involuntary, and by hindering this, it at once stops life.

All researches on this subject point to the fact that something under one per cent. only of carbon monoxide in air renders it fatal to animal life, and this at first seems an insuperable objection to the use of water gas, and has, indeed, influenced the authorities in several towns, notably Paris, to forbid its introduction for domestic consumption. Let us, however, carefully examine the subject, and see, by the aid of actual figures, what the risk amounts to compared with the risks of ordinary coal gas.

Many experiments have been made with the view of determining the per-centage of carbon monoxide in air which is fatal to human—or, rather, animal—life, and the most reliable as well as the latest results are those obtained by Dr. Stevenson, of Guy's Hospital, in consequence of the two deaths which took place at the Leeds forge from inhaling uncarburetted water gas containing 40 per cent. of carbon monoxide. He found that one per cent. visibly affected a mouse in one and a half minutes, and in one hour and three-quarters killed it, whilst one-tenth of a per cent. was highly injurious. Let us, for the sake of argument, take this last figure 0.1 per cent. as being a fatal quantity, so as to be well within the mark.

In ordinary carburetted water gas as supplied by the superheater processes, such as the Lowe, Springer, &c., the usual per-centage of carbon monoxide is 26 per cent., but in the Van Steenbergh gas—for certain chemical reasons to be discussed later on—it is generally about 18 per cent., and rarely rises to 20 per cent. An ordinary bedroom will be, say, 12 ft. \times 15 ft. \times 10 ft., and will therefore contain 1,800 cubic feet of air, and such a room would be lighted by a single batwing burner consuming not more than four cubic feet of gas per hour. Suppose now the inmate of that room retires to bed in such a condition of mental aberration that he prefers to blow out the gas rather than take the ordinary course of turning it off—a process, by the way, of putting out gas which is decidedly easier in theory than in practice, especially in his presumed mental condition—you would have in one hour the 1,800 cubic feet of gas in the room mixed

with four-fifths of a cubic foot of carbon monoxide—the carburetted water gas being supposed to contain 20 per cent.—or 0.04 per cent. In such a room, however, if the doors and windows were absolutely air-tight, and there was no fireplace, diffusion through the walls would change the entire air once an hour, so that the per-centage would not rise above 0.04; whilst in any ordinary room imperfect workmanship and an open chimney would change it four times in the hour, reducing the per-centage to 0.01, a quantity which the most inveterate enemy of water gas could not claim would do more than produce a bad headache, an ailment quite as likely to have been caused by the same factor that brought about the blowing out of the gas.

Moreover, we are now talking about the use of carburetted water gas as an enricher of coal gas, and not as an illuminant to be consumed *per se*, and we may calculate that it would be probably used to enrich a 16-candle coal gas up to 17.5-candle power. To do this 25 per cent. of 22-candle power carburetted water gas would have to be mixed with it, and taking the per-centage of carbon monoxide in London gas at 5 per cent.—a very fair average figure—and 18 per cent. as the amount present in the Van Steenberg gas, we have 8.25 per cent. of carbon monoxide in the gas as sent out—a per-centage hardly exceeding that which is found in the rich canal gas supplied to such towns as Glasgow, where I am not aware of an unusual number of deaths occurring from carbon monoxide poisoning.

The carburetted water gas has a smell every bit as strong as coal gas, and a leak would be detected with equal facility by the nose; and I think you will agree with me, that the cry raised against the use of carburetted water gas for this reason, is one of the same character that hampered the introduction of coal gas itself at the commencement of this century.

We must now turn to the chemical actions which are taking place in the generator of the water gas plant, and these are more complex in the case of the Van Steenberg plant than in those of the Lowe type, and, for that reason, yield a gas of more satisfactory composition.

Taking gas as made by the Lowe or Springer process, and contrasting it with the Van Steenberg gas, we are at once struck by several marked differences.

In the first place the hydrogen is far higher and the marsh gas or methane lower in the Van Steenberg than in the Lowe process, this being due to the sharper cracking that takes

	Lowe gas.	Van Steenberg gas.
Hydrogen	27.14	46.75
Marsh gas	25.35	11.27
Carbon monoxide	26.84	18.65
Illuminants.....	14.63	7.59
Ethane ;	—	6.82
Carbon dioxide ¹	3.02	0.50
Oxygen	0.15	0.17
Nitrogen.....	2.87	8.25
	100.00	100.00

place in the short column of cherry-red coke, as compared with the lower temperature employed for a longer space of time in the Lowe superheater. Next we notice a difference of 10 per cent. in the carbon monoxide, which is greatly reduced in the Steenberg generator by the carbon monoxide and marsh gas reacting on each other as they pass over the red-hot surface of coke with formation of acetylene, which adds to the illuminants, this action also reducing the quantity of marsh gas present. In the illuminants, if we add the higher members of the methane series present to the olefines, we see they are about equal in each gas, whilst the low per-centage of nitrogen in the Lowe gas is due to more careful working, and could easily be attained with the Van Steenberg plant by allowing the first portion of water gas to wash out the producer gas before the hopper on top is closed.

The cracking of the naphtha by the red-hot coke is undoubtedly a great advantage, for, as I have pointed out, the cracking of Russian petroleum is an exothermic reaction, so that the coke at the top of the generator gets hotter and hotter, and it is no unusual thing to see the coke at the beginning of the make cherry-red at the bottom, and dull red at the top, whilst at the end of the make it is almost black at the bottom, and cherry-red at the top, in this way attaining the same advantage in working that the Springer and Loomis do by their down blast, that is, having the fuel at its hottest where the gas finally leaves it, so as to reduce the quantity of carbon dioxide, and so lessen the expense of purification.

It will be well now to turn for a few moments to the gas obtained by cracking the light petroleum oils by themselves. The Russian and American petroleum differ so widely in composition, that it was necessary to see in what way the gases obtained from them differed; and to do this, equal quantities of American naphtha and a Russian naphtha were cracked, by passing through an iron tube filled

with coke, and in each case heated to a cherry-red heat, the gases being measured, and then analysed, with the following results:—

	American.	Russian.
No. of cubic feet per gallon	72	104
Hydrogen	26.0	45.3
Methane	41.6	22.3
Ethane	12.5	13.9
Olefines	14.1	11.6
Carbon monoxide	3.3	3.5
Carbon dioxide	1.7	2.3
Oxygen	0.8	1.1
Nitrogen	Nil.	Nil.
	100.0	100.0

Showing that, if the Russian oil is a little lower in illuminants, it quite makes up by extra volume, but it seemed to me, to deposit a much larger proportion of carbon.

Taking $2\frac{1}{2}$ gallons of American naphtha, it would give roughly 180 cubic feet of gas of the above composition, whilst the remaining gas would be the ordinary water gas. Taking the analysis of this as given, and calculating from it what would be the composition of a mixture of it with the naphtha gas, we obtain:—

	Calculated.	Actual.
Hydrogen	47.09	42.09
Methane	5.48	11.27
Olefines	2.53	7.59
Ethane	2.17	6.32
Carbon monoxide..	30.07	18.65
Carbon dioxide....	3.78	2.32
Oxygen	0.56	0.17
Nitrogen	7.17	8.25
Sulphuretted hydro- gen	1.15	2.84
	100.00	100.00

Showing how great the effect is of the diluents in the water gas in preventing the over-cracking of the hydrocarbons, as shown by the increase in the per-centage of them present in the finished gas; whilst the enormous reduction in the amount of carbon monoxide present is due to the interaction between it and the paraffin hydrocarbons in the presence of red-hot carbon, a point which makes the Van Steenberg apparatus enormously superior to any of the superheater forms of plant.

After all said and done, however, the reactions taking place, although they have an intense fascination for the chemist, are not the factors which the gas manager deems the most important, the cost of any given process being the test by which it must stand or fall;

and it will be well now to consider, as far as it is possible, the expense of enriching coal gas by the various methods I have brought before you.

In order to be well above the prescribed limit of illuminating power at all parts of an extended service, the gas at the works must be sent out at an illuminating power of 17.5 candles, and we may, I think, fairly take it that 16-candle coal gas, as made by the big London companies, cost, as nearly as can be, 1s. per 1,000 cubic feet in the holder, and the question we have now to solve is the cost of enriching it from 16 to 17.5-candle power. When this is done by cannel, the cost is 2.6 pence per candle power, so that the extra $1\frac{1}{2}$ would cost 4d. per 1,000.

Carburetted by the vapours of gasoline by the Maxim-Clarke process, cost $1\frac{3}{4}$ d. per 1,000, so that the extra candle power would mean an expenditure of 2.62d. Unfortunately, I have no figures upon which to calculate the cost of producing such a gas by the Dinsmore process, but with the three important water gas enrichers we can deal.

Using Russian fuel oil, which can be obtained in bulk in London at 3d. per gallon, the proprietors of the Springer plant guarantee $5\frac{1}{2}$ -candle power per 1,000 cubic feet of gas per gallon used, so that, to produce a 22-candle gas, 4 gallons would be used. The cost per 1,000 cubic feet may be roughly tabulated, as the coke used amounts to about 40 lbs.

	s.	d.
Oil	1	0
Coke	0	3
Labour and purification....	0	2
Charge on plant	0	1
	1	6

Twenty-five per cent. of 12-candle gas when mixed with 75 per cent. of the 16-candle gas, gives the required 17.5-candle gas, which would therefore cost 1s. $1\frac{1}{2}$ d., or the enrichment would have cost $1\frac{1}{2}$ d.

By the Lowe process, an increase of 5.3-candle power is guaranteed for the consumption of a gallon of the same oil, so that the cost would be a shade higher, all other factors remaining the same, whilst with the Van Steenberg process both grade of oil and consumption of fuel vary from either of these processes. In order to obtain a thousand cubic feet of 22-candle gas two and a half gallons of the lighter grade oil would be consumed, and I am informed that there is now no difficulty in obtaining oil of the right grade in London in

bulk at 4d. per gallon, which would make the cost—

	s.	d.
Two and a half gallons of oil	0	10
Thirty pounds of coke	0	2 $\frac{1}{4}$
Labour and purification	0	2
Charge on plant	0	0 $\frac{3}{4}$
	1	3

And the enriched coal gas would, therefore, cost 1s. 0 $\frac{3}{4}$ d. per thousand, the extra 1 $\frac{1}{2}$ -candle power having been gained at an expense of $\frac{3}{4}$ d. or $\frac{1}{2}$ d. per candle.

Tabulating these results we have—Cost of enriching a 16-candle gas up to 17·5-candle power per 1,000 cubic feet by cannel coal, 4d. ; by Maxim-Clarke process, 2 $\frac{6}{10}$ d. ; by Lowe or Springer water gas, 1 $\frac{1}{2}$ d. ; by Van Steenberg water gas, $\frac{3}{4}$ d.

In reviewing this important subject, and bringing a wide range of experimental work to bear upon it, I have, as far as is possible, divested my mind of bias towards any particular process, and I can honestly claim that the fact of the Van Steenberg process showing such great superiority is due to the force of carefully obtained experimental figures, corroborated by an experienced and widely-known gas chemist, and by the chief gas examiner of the city.

In adopting any new method, the mind of the gas manager must to a great extent be influenced by the circumstances of the times, and the enormous importance of the labour question is a main factor at the present moment ; with masters and men living in a strained condition which may at any moment break into open warfare, the adoption of such water gas processes would relieve the manager of a burden which is growing almost too heavy to be borne.

Combining, as such processes do, the maximum rate of production with the minimum amount of labour, they practically solve the labour question. Requiring only one-tenth the number of retort-house hands that are at present employed, the carburetted water gas can be used for enrichment until troubles arise, and then the gas can be used pure and simple, with a hardly perceptible increase in expense, whilst the rapidity of make will also give the gas manager an important ally in the hour of fog, or in case of any other unexpected strain on his resources.

One of the first questions asked by the practical gas maker will be—"What guarantee can you give that as soon as we have erected

plant, and got used to the new process of manufacture, a sudden rise in the price of oil will not take place, and leave us in worse plight than we were before ;" and the only answer to this is, that, as far as it is possible to judge anything, this event is not likely to take place in our time. A year ago, the prospects of the oil trade looked black, as the output of American oil was in the hands of a powerful ring, who seemed likely also to obtain control of the Russian supplies ; but, fortunately, this was averted, and, at the present moment, the Russian pipe lines are flooding the market with an abundant supply, which those best able to judge tell us is practically inexhaustible, so that prices may be expected to have a downward rather than an upward tendency. But even should a huge monopoly be created, I think I have found a source of light at home which will hold its own against any foreign illuminant in the market.

For a long time I have felt that in this country we had sources of light and power which only needed development, and the discovery of the right way to use them, in order to give an entirely new complexion to the question of carburetting ; and now, by the aid of the engineering skill and technical knowledge of Mr. Staveley, of Baghill, near Pontefract, I think it is found.

At three or four of the Scotch iron works the Furnace Gases Company are paying a yearly rental for the right of collecting the smoke and gases from the blast furnaces. These are passed through several miles of wrought iron tubing, diminishing in size from 6 feet down to about 18 inches ; and as the gases cool, so there is deposited a considerable yield of oil.

At Messrs. Dixon's, at Glasgow, which is the smallest of these installations, they pump and collect about 60,000,000 cubic feet of furnace gas per day ; and recover, on an average, 25,000 gallons of furnace oils per week, using the residual gases, consisting chiefly of carbon monoxide, as fuel for distilling, and other purposes, whilst a considerable yield of sulphate of ammonia is also obtained. In the same way a small per-centage of the coke ovens are fitted with condensing gear, and produce a considerable yield of oil, for which, however, there is a very limited market, the chief use being for lucigen and other lamps of the same description, and for pickling timber for railway sleepers, &c. ; the result being that, four years ago, it could be obtained in any quantity at $\frac{1}{2}$ d. per gallon, whilst since that it has been as high as 2 $\frac{1}{2}$ d. a gallon,

but is now about 2d., and shows a falling tendency. Make a market for this product, and the supply will be practically unlimited, as every blast-furnace and coke oven in the kingdom will put up plant for the recovery of the oil, and as with the limited plant now at work it would be perfectly easy to obtain 4,000,000 or 5,000,000 gallons per annum, an extension of the recovery process would mean a supply sufficiently large to meet all demands.

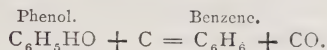
Many gas managers have, from time to time, tried if they could not use some of their creosote for gas-producing, but on heating it in retorts, &c., they have found the result has generally been a copious deposit of carbon, and a gas which has possessed little or no illuminating value. Now, the furnace and coke-oven oils are in composition somewhat akin to the creosote oil, so that at first sight it does not seem a hopeful field for search after a good carburetter; but the furnace oils have several points in which they differ from the coal-tar products. In the first place, they contain a certain per-centage of paraffin oil, and in the next, do not contain much naphthalene, in which the coal-tar oil is especially rich, and which would be a distinct drawback to their use.

The furnace oil as condensed contains about 30 per cent. to 50 per cent. of water, and in any case, this has to be removed by distilling; and Mr. Staveley has patented a process by which the distillation is continued after the water has gone off, and by condensing in a fractionating column of special construction, he is able to remove all the paraffin oil, a considerable quantity of cresol, a small quantity of phenol, and about 10 per cent. of pyridine bases, leaving the remainder of the oil in a better condition, and more valuable for pickling timber, which is its chief use.

If the mixed oil so obtained, which we may call "phenoloid oil," is cracked by itself, no very striking result is obtained, the 40 per cent. of paraffin present cracking in the usual way, and yielding a certain amount of illuminants, but if this oil be cracked in the presence of carbon, and be made to pass over and through a body of carbon heated to a dull red heat, then it is converted largely into benzene, the most valuable of the illuminants, and also being the one to which coal gas owes the largest proportion of its illuminating power, it is manifestly the right one to use in order to enrich it.

On cracking the phenoloid oil, the paraffins yield ethane, propane, and marsh gas, &c.,

in the usual way, whilst the phenol interacts with the carbon to form benzene—



And in the same way the cresol first breaks down to toluene in the presence of the carbon, and this in turn is broken down by the heat to benzene.

A great advantage of this oil is that the flashing point is 110, and so is well above the limit, thus doing away with the dangers and troubles inseparable from the storage of light naphtha in bulk.

In using this oil as an enricher, it must be cracked in the presence of carbon, and it is of the greatest importance that the temperature should not be too high, as the benzene is easily broken down to simpler hydrocarbons of far lower illuminating value. This fact is very clearly brought out by a series of experiments I have made, in which the phenoloid oil was cracked by passing it through an iron tube packed with coke and heated to various temperatures, the hydrocarbons being much more easily broken up under these conditions than if mixed with diluents, such as water gas:—

RESULTS OBTAINED ON CRACKING PHENOLOID OIL.

	I.	II.	III.
Temperature	600° C.	800° C.	1,000° C.
Volume of gas } per gallon .. }	41·6 c.f.	76·8 c.f.	121·6 cf.

COMPOSITION OF THE GAS.

Hydrogen	34·0	..	36·0	..	37·0
Methane	20·0	..	26·0	..	49·0
Olefines	11·0	..	5·0	..	Nil.
Ethane	16·0	..	9·0	..	Nil.
Carbon monoxide..	13·0	..	15·0	..	12·0
Carbon dioxide ..	2·0	..	4·0	..	2·0
Oxygen	2·0	..	1·0	..	Nil.
Nitrogen	2·0	..	4·0	..	Nil.

This analysis shows that, if the temperature is allowed to reach a cherry red, complete decomposition of the illuminating hydrocarbons is taking place, and a gas of practically no illuminating value results. The power of regulating the temperature and the body of carbon as a cracking medium in the Van Steenberg water-gas plant, especially fits it for using this oil, and removes the objections which could have been urged against the lighter naphthas.

This oil is at present not in the market; but given a demand, it can be produced in four

months, at the latest, in very large quantities, as the apparatus is very easy and cheap to erect, and the crude material can be plentifully obtained.

If this oil becomes, as I think it will, an important factor in the illumination of the future, it will mark as important an era in the history of our industries as any which the century has seen, as, by using it, you are giving smoke a commercial value, and this will do what the Society of Arts and the County Council have failed in—that is, to give us an improved atmosphere. If I were lecturing on an imaginary “Hygeia,” I should point out that the smoke of London contains large quantities of these oils, and they, by coating the drops of mist on which they condense, give the fog that haunts our streets that peculiar richness which is so irritating and injurious to the system; and, further, by preventing the water from being again easily taken up by the air, prolongs the duration of the fog. Make this oil a marketable commodity, and another twenty years will see London without a chimney; underground shafts will be run alongside the sewers; into these shafts by means of a down-draught all the products of combustion from our fires will be sucked by local pumping-stations, and the oil condensing in the tubes will serve in turn to illuminate our streets, instead of performing its former function of turning day into night and ruining our health: but as I am not at all sure of the engineering possibilities of such a scheme, I will leave its discovery to some other abler prophet than myself.

SIXTH ORDINARY MEETING.

Wednesday, January 14th, 1891: Professor FRANCIS ELGAR, LL.D., F.R.S.E., in the chair.

The following candidates were proposed for election as members of the Society:—

- Beadle, Clayton, care of William Joynson and Son, St. Mary Cray, Kent.
 Darley, James Jacob, 36, John-street, Bedford-row, W.C.
 De Woolfson, Lewis Estevan Green, 26, St. John's-hill, Shrewsbury.
 Earle, Hardman Arthur, 16, Victoria-street, S.W.
 Foster, Henry Llewellyn Thomas, Westminster Electric Supply Corporation, 32, Victoria-street, S.W.
 Hall, Charles Richard Guy, 13, St. Alban's-road, Kensington-court, W.

- Kloetgen, William John Hugo, 16, Watling-street, E.C.
 Lewis - Meredith, William, 7, Midland - road, Gloucester.
 Little, Henry, Baronshalt, East Twickenham.
 Lumley, Theodore, 37, Conduit-street, W.
 McKay, Andrew Davidson, 13, York-street, Liverpool.
 Mills, Major H. F., Junior United Service Club, S.W.
 Noble, Benjamin, Gloucester-house, Newcastle-on-Tyne.
 Rhodes, J. H. H. Wentworth, 27, Park-square, Leeds.
 Rivers, T. Francis, Sawbridgworth.
 Sewell, Robert, Bellary, India.
 Spoor, J. L., Stonecourt Cement Works, Greenhithe, Kent.
 Stapley, Richard, Norfolk-house, Norfolk-street, Strand, W.C.
 Thomas, John, Brook-house, Woodburn, Maidenhead.
 Touch, George Alexander, 47, Goldhurst-terrace, South Hampstead, N.W., and Winchester-house, Old Broad-street, E.C.
 Tyler, John William, Southwold-lodge, Cleveland-road, South Woodford, Essex.

The following candidates were balloted for, and duly elected Members of the Society:—

- Boyle, Courtenay, C.B., Board of Trade, Whitehall-gardens, S.W.
 Collum, George Ashbury, Cannon Brewery, St. John-street, Clerkenwell, E.C.
 Cundall, Frank, Lyndhurst-house, Wallington, Surrey.
 Pearce, Edward Toplis, 22, Hyde-road, Hoxton, N., and Junior Constitutional Club, S.W.
 Speirs, Edwin Robert, Dartmouth-chambers, 8, Theobald's-road, W.C., and 90, Queen-street, E.C.
 Wharton, James, Edge-hill, Netherhall-gardens, Hampstead, N.W.

The CHAIRMAN, in calling on Mr. Green to read his paper, said it was hardly necessary to say anything to recommend him to the meeting. Mr. Green was well known as an active member of one of the oldest, if not the oldest, shipbuilding firms in the country, and one of the most eminent. He was a sailor as well as a shipbuilder, and thoroughly understood the sea and its ways. Mr. Green had devoted himself to the improvement of the propulsion of life-boats, and had succeeded in overcoming many of the mechanical difficulties. The subject was not only important on account of the mechanical and scientific difficulties it presented, but was of vital importance from a humanitarian point of view. Everyone would commend and sympathise with Mr. Green, and also with the National Lifeboat Institu-

tion, for their endeavours to obtain a lifeboat that would be more powerful and effective than the ordinary boat propelled by oars, and better able to battle with the wind and waves, and to rescue unfortunate shipwrecked mariners from the common fate of those who "go down to the sea in ships."

The paper read was—

STEAM LIFEBOATS.

BY J. F. GREEN.

During the 1890 meeting of the British Association at Leeds, I read a short paper on the hydraulic steam lifeboat we were building for the Royal National Lifeboat Institution. Since then, she has been completed, and sent out on real lifeboat service, and in the most terrific weather, so that I am now in a position to supplement my former paper by giving actual proofs of her great value as a life-saving vessel.

This, the first steam lifeboat ever constructed, has been most appropriately named the *Duke of Northumberland*, after the present representative of a family inseparably associated with lifeboat work.

His Grace showed his complete confidence in the boat by steaming in her right through the crowded city reaches of the Thames to historic Sion-house, where he disembarked, highly pleased with the handiness and general arrangement of the vessel.

This successful termination of the much-vexed question of how to apply steam to a lifeboat, has given great satisfaction in shipping circles, and especially at the Lifeboat Institution, where, for some years past, the members have been earnestly endeavouring to find means of propelling lifeboats mechanically; and in April, 1886, they appointed a special sub-committee to inquire fully into the question. This committee visited the Liverpool National Exhibition, but regretfully reported that they were unable to recommend the adoption of any pattern of steam lifeboat at present.

The following May, nothing daunted by the failure of former endeavours, the Institution offered gold and silver medals to competitors all over the world for models or drawings of a mechanically-propelled lifeboat, best adapted to meet the conditions under which lifeboats are called upon to perform their work. In response to this offer, numerous models and drawings were received from all parts of Great

Britain, the Continent, and even from the United States. These were submitted to Sir Frederick Bramwell, Bart., F.R.S., Sir Digby Murray, Bart., of the Board of Trade, and Mr. John J. Thornycroft, gentlemen of world-wide celebrity for their knowledge of kindred matters, but in no way connected with the Institution. These judges, after a lengthy and careful examination of all models and drawings which had been sent in, reported that not one of them was suited for the purpose for which it was intended.

The committee of the Institution, although disappointed at this termination of the competition, nevertheless still hoped that science would help them in the matter. The question had arrived at this stage when we entered into negotiation with the Lifeboat Institution, our object being rather to work in conjunction with their officers, and thus produce a thoroughly practical mechanically-propelled lifeboat.

Electricity, stored in accumulators, was reluctantly given up, as it possessed many great advantages; but the weight was fatal, being about one ton per horse, instead of the three-quarters of a cwt. we now work with.

This light weight is, of course, procured by using forced draught, which, though possibly open to objections in vessels continually steaming, is invaluable here, as, besides giving great power just when required, it ventilates both engine-room and stoke-hold when closed in a heavy sea. In fact, forced draught, and the great perfection arrived at in the manufacture of mild steel, greatly facilitated the solving of the problem, as in each case a maximum of efficiency is obtained with a minimum of weight; and without this satisfactory basis to work upon, it would be hopeless to try and combine the many qualifications necessary for a boat of this class.

Negotiations for the little vessel I am about to describe began in the early part of 1888, and many and lengthy were the discussions held at the offices of the Royal National Lifeboat Institution before they accepted the design from our firm, and gave us the order to build a steam lifeboat. The design contained many peculiarities, and the suggested mode of propulsion was the water-jet propeller.

Without at all proposing to go into the principles of hydraulic propulsion, I would just remark that the term "jet propeller" is, I think, rather misleading, and it has, I know, given to some the idea that motion is obtained by the thrust of the jets against the solid water; whereas, of course, the propelling

power is really obtained by relieving at certain points the enormous pressure in the turbine. The vessel is consequently driven in an opposite direction to the relieving jets.

A very apt definition is given by Mr. J. R. Ruthven. He says:—"There has been much confusion of ideas as to the fundamental nature of the water-jet propeller. The performance of a rocket in its flight is perhaps the best illustration. Here we have an internal force producing motion by the unbalanced pressure of the explosive mixture."

Before proceeding further it would be well to give our reasons for adopting the hydraulic system; as on the mere face of it, the waste of power would appear to be a serious objection. This objection however is, I think, rather theoretical than practical, for the performances of this boat on her numerous trials, as well as her actual services since, have tended to prove that no other method of propulsion would drive a similar vessel, even at the same speed, in anything of a sea, to say nothing of all the other advantages gained by the hydraulic principle. In fact, no other type of mechanical propulsion appeared to be at all practicable.

A paddle vessel in such a service is of course out of the question, as she is so easily disabled, and under no circumstances could she be used as a sailing vessel.

The screw-propeller in smooth water is the most efficient way of absorbing the power developed, but with such a shallow draft, and on such a service, the propeller would be continually out of the water, and consequently half the time practically useless, to say nothing of the danger involved; for of course the racing of a propeller has a most damaging effect upon the machinery, apart from the chances of breaking the main-shaft, and consequent total disablement of the boat.

Further, there is the continued risk of fouling the screw with wreckage, or breaking it when taking the ground, and, lastly, the sailing power would be greatly reduced by the dragging of the screw-propeller through the water. Therefore, both these types of steam vessels, admirable as they are in their own particular spheres, must be always impracticable for lifeboat service; and, having this in view, it was considered that the hydraulic principle alone remained.

The advantages set forth and claimed for this lifeboat are as follows (and the long series of exhaustive trials which have been held at Sheerness, Southend, and Harwich, and her

actual services since, have fully proved them to be genuine):—

1. The propelling power in the vessel is instantaneous, and as efficient in heavy seas as in smooth water.

2. There is no racing or injurious effects to the machinery, however much she rolls or pitches.

3. The vibration experienced is very much less than that met with in a screw or paddle-boat.

4. As the engine only runs in one direction, the complication, weight, and wear and tear of machinery is greatly reduced, and there is no loss of time, due to stopping and reversing, for going astern.

5. The management of the vessel is entirely in the hands of the officer on deck, who, by working two handles, fitted on the after end of the engine casing, can thus control the jets, and "stop," "go-ahead," or "go-astern," without any communication with the engine-room.

6. There are no serious obstacles under water to interfere with her sailing qualities and affect her, if she should take the ground, or run foul of ropes or wreckage.

7. Should anything happen to the rudder, she will steer well with the turbine alone; and, with both together, her manœuvring power is far in excess of any other known steering arrangement.

8. The deck hands arrive at the wreck fresh, and ready for their work. This, of course, applies to all mechanically-worked lifeboats.

This type, therefore, having been finally adopted, it only remained to fit the machinery into a vessel sufficiently strong, light, seaworthy, handy, and fast. Neither time nor pains were spared in constructing a boat of the greatest possible strength compatible with lightness; and the steel employed (samples of which were forwarded to the Lifeboat Institution) was subjected to tests far in excess of Lloyd's latest requirements.

The rivetting is a special feature, being one-third more than is usual in similar vessels. Where a seam would have been double rivetted in a torpedo-boat, it is treble rivetted here, and there is not one single-rivetted seam throughout the whole vessel. Thus is adduced the fact that in this little vessel, only 50 feet in length, there are 72,000 rivets, exclusive of all the screw-bolts and fastenings of the machinery. In other words, these rivets, placed end to end, would reach three-quarters of a mile.

The strength and seaworthiness is further amplified by a complete system of longitudinal and transverse water-tight bulkheads, giving in all fifteen water-tight compartments, connected by sluice-valves with the engine-room, which can be readily drained by bilge-pumps and steam ejectors.

She was launched on the last day of May, 1889, on ways $1\frac{1}{2}$ inches to 1 foot, her mean draft was then 1 foot $11\frac{3}{8}$ inches; weight, 9 tons 8 cwt. Great attention was paid to ensure stability, and several tests were made, one being of a very practical nature. All the weights were placed on board, and a heavy parbuckle was placed completely round the vessel. The end of this was fastened to a powerful steam crane, furnished with a dynamometer, and the boat was then inclined until she lay on her beam ends. In this position, lack of stability would have been apparent by her turning completely over, which she was quite free to do; but so confident were we of the accuracy of our calculations (which showed that the boat possessed righting powers of over 100 degrees), that a member of our firm, and a naval architect, remained on board during the whole of the experiment. The centre of gravity was found by inclination to be 4 feet 2 inches above the base line, and the metre-centre is 2 feet above this.

On August 4th, 1890, she was finally tried for speed by Captain Chetwynd, chief inspector of the Lifeboat Institution, on the "Maplin." All her weights were on board, and she averaged a mean speed of 9.175 knots an hour. She was tried at different times on even keel, by the head, and by the stern, and it was found that her best trim was about 4 inches by the stern, and this is how she now is when going out to a wreck, with two tons of water in the ballast tanks to represent a shipwrecked crew; coxswain and three hands in the well; two engineers in the engine-rooms; two stokers in stokehold; one hand forward; three tons of coal in bunkers, and complete outfit on board.

Opinions differed considerably as to what her trim should be going full speed. Some said she would go down aft like a screw; others, that she would bury herself forward like a paddle. Two instantaneous photographs were taken whilst running about seven knots which showed that she varied her trim very little, and this towards increasing the draft aft. The photographs show how very little water she raises at her stem.

Tests were also made with her manœuvring

powers, which proved to be remarkably good both with rudder and turbine. She completed the circles as follows:—

	Secs.
Going ahead full speed, rudder kept amidships by self-holding steering gear;	
turbine alone	50
Going astern full speed, rudder kept amidships by self-holding steering gear;	
turbine alone	63
Going ahead, rudder alone	50
Going ahead, with rudder and turbine....	40

I think this last time is a record. I never heard of any other boat completing the circle in so short a time. She was brought from full speed to dead stop in thirteen seconds, and from dead stop to gathered headway in four seconds. I do not think these two, either, have been beaten.

These tests, which were conducted with the greatest accuracy, showed conclusively how entirely the vessel is under the control of the officer on deck, without necessitating any communication with the engine-room.

On the 24th July, 1890, thirty representatives of the Press were taken a run down the river, and were delighted with the boat. On the same day, the Secretary of the Lifeboat Institution sent reports to 1,500 papers in the United Kingdom, and a lengthy account was cabled over to New York.

On the 12th August, it was determined by the Lifeboat Institution to see if it were possible to choke the intake, and various apparatus representing wreckage were hauled under the boat when she was going at three-quarter speed.

In the generality of cases the boat passed over them at once, and in no case was she in danger of being disabled, and it was the decided opinion of all on board that no other type of steam vessel could have gone through the experiment without her propeller being stopped, if not also materially injured.

The dimensions, scantlings, &c., are as follows:—Length, 50 feet; beam moulded, 12 feet; breadth, extreme, 14 feet $3\frac{3}{4}$ inches; extreme draft with 3 tons of coal, 30 passengers, 5 deck-hands, 2 engineers, 2 stokers, and full outfit, 3 feet 6 inches; displacement at this draft, 23 tons; speed at this draft, 9.175 knots; indicated horse-power 170; steam 130 lbs.; stoke-hold pressure, 2 to 3 inches; revolutions (maximum), 450; vacuum 25 inches; consumption, 2 cwt. per hour.

Under natural draft, with 230 revolutions, she does about 5 knots. Steaming like this,

and with sails set, she goes remarkably well, even in light winds, if at all fair. Her consumption then is very small.

Frames and reverse frames, $1\frac{1}{2} \times 1 \times \frac{1}{8}$; beams, $2 \times 1 \times \frac{3}{16}$; floors, 5 lbs. per square foot; transverse and longitudinal bulkheads, $3\frac{1}{2}$ lbs. per square foot; keel plates, $5\frac{1}{2}$ lbs. per square foot; shell plating, $5\frac{1}{2}$ to $4\frac{1}{2}$ lbs. per square foot; deck plaiting, 4 lbs. per square foot. The laps of shell were arranged for double rivetting, and the butts for treble rivetting.

The propelling machinery was constructed for us by Messrs. Thornycroft & Co., of Chiswick, the well-known torpedo-boat builders; and their great reputation for good work has been fully sustained here.

The engines are of the horizontal compound surface-condensing type, with cylinders $18\frac{1}{2} \times 14\frac{1}{2}$, and 12 inch stroke. The boiler is Thornycroft's patent tubulous pattern, having a heating surface of 606 square feet, and a grate surface of $8\frac{1}{2}$ square feet. The tubes are of steel, and every one has been tested up to 600 lbs. They have been well looked after, and have consequently given no sort or kind of trouble whatever.

We have found from experience that, starting with everything cold, it takes about twenty minutes to get over 100 lbs. of steam. The boiler is practically free from priming, even when the boat is in a lively sea. The fan-engine supplying the blast is inverted, with a single cylinder, and runs about 1,000 revolutions a minute. The turbine, 2 feet 6 inches in diameter, is nearly horizontal, and delivers water through the outlets at the rate of 1 ton per second, and draws its supply through a vertical scoop-shaped inlet, 1.52 square feet in diameter, designed by Mr. Thornycroft, who says this arrangement of inlet effects a saving over an ordinary flush inlet in the ratio of eighteen to twenty-five. It is protected on each side by an elm keel, which also serves the purpose of keeping the boat upright when she takes the ground. The go-ahead outlets, or nozzles, are placed, for protection, as low down as possible, and for the same reason the go-astern are placed high up, under the rubbing piece. These nozzles are 9 inches in diameter. The valves directing the jets through the nozzles are worked by two handles fixed on the after end of the engine-house. To go-ahead, both handles are turned outwards, and both inwards to go-astern. The indicators, working in connection with these handles, are picked out with luminous paint, to show at night.

Communication with the engine-room is maintained by means of a bell and a speaking tube. The engine and boiler are each in separate water-tight compartments, both of which are efficiently ventilated, when closed, by means of the forced draft fan, and by a patent cowl when natural draft alone is used.

The sailing powers of this boat have, of course, been well tested, and she sails well off the wind. She is rigged with a lug sail and jib, and her mast is fitted into a tabernacle, and lowers between the two funnels into a strong iron crutch.

The well, perhaps the most important feature to a shipwrecked crew, is capable of comfortably accommodating 30 passengers, and is situated abaft the machinery space. The bottom and sides of this well are furnished with ten large freeing valves of the usual lifeboat type, which will effectually clear it of water in the event of its being flooded. It is surrounded by substantial teak lockers, forming seats, and its deck is covered with teak gratings. Under this deck are two watertight tanks holding 1 ton each, or representing the weight of a shipwrecked crew. When leaving for a wreck they will be full, but on return the water can be pumped out by a donkey engine.

The remainder of the boat's deck is covered with corticine, to prevent slipping, a material which will successfully withstand the action of the sea water. A small, but powerful, gun-metal capstan is fitted on the forward hood, the engine of which is situated in a watertight compartment below, fitted with a watertight door. Portable stanchions, which can be quickly unshipped, are fixed on each side of the vessel, immediately inside the rubbing pieces; and the usual hand-rail and man-ropes are on the forward and after hoods.

The anchor is of the Institution pattern, and is catted by a handy little davitt, the outcome of many experiments; and the $2\frac{1}{4}$ inch galvanised wire hawser is 120 fathoms long, and attached to a reel fixed in a box in the well. In case of wishing to slip and run, powerful wire rippers are fixed on the after end of the engine-house, which will at once sever the hawser.

Much attention has been devoted to her steering-gear, which, for additional security, is two-fold, namely, yoke lines and wheel, the latter consisting of a well-arranged, patent self-holding screw gear.

The rudder is attached to the boat by Hick-

man's patent fittings, and is so constructed that the lower part rises and falls automatically.

The consumption of coal, even under forced draft, has been proved to be remarkably small, averaging only 2 cwt. an hour; so that she can steam out to a wreck with 30 hours' coal, thus giving her a radius of action of 254 knots, at a speed of $8\frac{1}{2}$ knots.

She is, of course, painted in the well-known colours of the National Lifeboat Institution, and presents a remarkably smart and business-like appearance.

She left Blackwall for Harwich on the 19th September, 1890, under the charge of Mr. Graham, the inspector of lifeboats, in whose district she is at present stationed, and towed round one of the Institution's sailing lifeboats, and here, as also later on, showed she possessed remarkable towing powers. On her arrival I received the following from the chief engineer on board:—

"DEAR SIR,—We left Blackwall Pier 7 a.m., and arrived at Gravesend 9 a.m. The distance is twenty-one miles, but we had the tide in our favour. We there took Mr. Smith on board, the Under-Secretary of the Institution. We left at 9.45 a.m., and arrived at Sheerness at 12.45 p.m. As we had the tide against us from Lower Hope, I think the time is very good, considering we were towing the other boat, with all her crew and gear on board. Captain Graham and Mr. Smith were very pleased with her towing powers; it seemed to make very little difference to her in any way. The engines were making 340 revolutions per minute. We left Sheerness on Saturday morning 7 a.m., and got alongside the quay at Harwich at 12.30 p.m., and I think that is very good, considering we had the tide against us about half the way. When we got round the Mouse Lightship they set sail on both boats, the wind after that point being in our favour as far as Harwich. She went splendidly under sail and steam, engines running 340, which is a comfortable speed. Everything went splendidly all the way without the slightest hitch. The coxwain and crew consider she behaves splendidly when towing. On arrival we coaled and got ready at once, and are now anxiously waiting to enter upon our duties. On Monday, Captain Graham finally inspected her and all her gear, and passed her to his entire satisfaction. The Harwich crew are eager for a call out in her, and so am I.

"Yours obediently,

"A. H. SIMMONS."

On Wednesday, the 7th October, she had her first call to embark on her real duty of saving life, and the following letter that appeared in the Harwich papers will best explain her behaviour on the occasion:—

"The steam lifeboat *Duke of Northumberland* was called out on Wednesday morning, at 12.20 a.m., to go to a ship in distress on the Cork Sand. The men were on board and fires lit at 12.27 a.m., and were under weigh, ready for full speed, at 12.48 a.m. A delay occurred in her departure owing to the difficulty in getting clear of small craft moored close to her berth. To clear one of these she had to go full speed astern, and, in doing so, grounded on a sand-bank, and was delayed twelve minutes in consequence. She towed out the Reserve Boat No. 3, and arrived alongside the ship in distress at 2 a.m., and landed men on board to render any assistance possible. The vessel was the brigantine *Ada*, of Faversham, bound for London. The steam lifeboat proved herself to be a most handy and suitable craft for the purpose for which she is intended, being able to round a ship and go alongside, or take a crew out with the greatest possible ease in shallow water, with a heavy sea running. She steamed round about the distressed ship until she was got off at high water, and then left with the reserve boat in tow, and arrived back at her station in Harwich at 8 p.m."

Her next adventure was on October 20th, which is best explained by the following extract from the *East Anglian Daily Times*:—

"At twenty minutes past three o'clock on Monday morning the lookout of the Coastguard at Harwich observed signals from the Shipwash, and immediately summoned the lifeboat's crew, which manned the Reserve Boat No. 3, and left the harbour shortly before 4 o'clock, under sail. She was followed by the steam lifeboat, *Duke of Northumberland*, and taken in tow just outside the harbour, where a course was steered, against a north-east wind and heavy sea, for the Cork Lightship, which was reached about 5 o'clock. The lifeboat men were informed there was a ship on the Shipwash Sands, and they made for the locality.

"On arrival about 6 o'clock, they found the iron screw steamer, *Achilles*, of Sunderland, 913 tons, and 130 horse-power, from Riga to London with railway sleepers, aground on the sand. The captain of the steamer accepted the services of both lifeboats, and the tug *Harwich* which had followed. All hands at once commenced to throw overboard her deck cargo, and also cargo from the main-hatch, between 300 and 400 tons, after which the ship righted. She was towed off the sand at high water at 4 p.m., by the united aid of the steam lifeboat and the tug *Harwich*, and was taken in tow, and left for London in charge of Captain Keable. The crews of the lifeboats are delighted with the manner in which the steam lifeboat, *Duke of Northumberland*, behaved. She is considered a splendid sea boat, and they have every confidence she will be a great help in saving life."

Referring to the same wreck, the account in the London papers ended as follows:—

"The steam lifeboat which has recently been placed on the station behaved admirably."

The following extract is from a letter of Captain the Hon. H. W. Chetwynd, chief inspector of the Lifeboat Institution:—

"I was on the point of writing to tell you that the *Duke of Northumberland* was out in a heavy gale and very heavy sea on Friday last, and worked perfectly. Nothing could be better than both coxwain's and chief engineer's reports. She shipped no heavy water at all, only spray. She was between the Sunk Lightship and the Long Sand, in a whole gale from north north-west, which gave a ten mile drift off the land for the sea to get up in."

On the 23rd October the coxwain called at Blackwall-yard. He said, "she is a perfect success, and stands the sea splendidly; and we have every confidence in her."

The following is an extract from the chief engineer's letter to one of our foreman:—

"24th October, 1890.

"She rides like a duck on the water. We went out in that gale the other day for a trial, and she behaved well. We went out nearly 18 miles, with the sea and the wind, and then had to return right in the teeth of the gale and a tremendous sea. She went about 7 knots against that, and shipped no heavy water, which is very much in her favour. She stood right up on end to it at times; and I must say she is a splendid boat, and so do the crew. I would go anywhere with her. I suppose you have seen accounts in the papers of her success."

The following in another letter received by a foreman from the chief engineer on November 23rd:—

"DEAR SIR,—No doubt you have heard about the good work we are doing with the little boat *Duke of Northumberland*. She has proved herself a little beauty, and no one can say she has not been tried in a full gale of wind, for we have been out in three heavy gales, and she has answered splendidly, and made splendid headway against the wind and sea, and in the breakers on the sand. The lifeboat men have never seen anything to equal her before, for there is some sea moving on the sands in a gale of wind, and you would think so, too, if you were in her; for she stands up on end to it, and then makes splendid headway against it. We have been called out to several wrecks, two of them salvage ones; the last one had cargo alone worth £14,000, and her crew had all left her when we got there. We boarded her and got her off, or the ship must have gone to pieces in a very short time."

The following is an official record of her exercise trips and services, from the time she arrived at Harwich to December 24th:—

Record of Exercise Trips and Services rendered by Steam Lifeboat "Duke of Northumberland," since she left London, Sept. 19, 1890, up to the present date—Dec. 24, 1890.

Left Blackwall Pier, Sept. 19, 7 a.m. Arrived at Gravesend 9 a.m.; so far we had tide in our favour. Left Gravesend 9.45 a.m., arrived Sheerness 12.15 p.m.; we had tide against us from Gravesend to Sheerness.

Sept. 20.—Left Sheerness 7 a.m. Sea rough all the way; we had tide against us half the way. Arrived at Harwich 12.30 p.m. We had the Reserve Boat No. 3 in tow from Blackwall to Harwich. Capt. Graham was in command of the boats.

October 8, 1890.—Gun fired at 12.20 a.m. for ship in distress on Cork Sand. Fires lit 12.27 a.m., ready for full speed 12.48 a.m. There was a delay of 12 minutes after starting, in getting clear of other craft moored close to her berth, and in doing so grounded on a bank; there were stones and sand passing through the turbine for five minutes, until she got clear of bank. We then proceeded to sea, and picked up Reserve Boat No. 3 off Beach End. Arrived at Cork Lightship 1.30 a.m., and inquired in what direction the ship lay. We were told that she was on the edge of Cork Sand. Going over the Sand we saw the lights of the ship; we went straight to her, arriving there at 2 a.m. She was the brig *Ada*, of Faversham, bound from Shields to London, coal laden; tonnage, 171 tons; Burrows, master. We went alongside and put five men aboard to render them any assistance they required. We then left the reserve boat moored astern of her, and steamed round her several times sounding and taking her bearings. We went round the tugs, and were told that there were two men adrift in a small boat belonging to tug *Merrimac*, which had arrived to assist. We then went in search, and found them about two miles off near the breakers we took them on board, and their boat in tow; they had lost one oar, and had we not picked them up then they would have been capsized in the breakers, and in all probability lost. We put them back on their tug, and steamed through the breakers, which were very heavy, as there was a good sea running. We then assisted until she was towed off at high water, and returned with reserve boat in tow, and arrived at Harwich 8.30 a.m., everything having gone well during the service rendered to save vessel and crew.

October 16, 1890.—Received orders from chief officer of Coastguard to proceed to sea on a trial trip, the weather being very stormy, and heavy W.N.W. wind blowing. We got under way 10.30 a.m., and proceeded on the trial, engines running 360 revolutions per minute. Spoke Sunk Lightship at 12.20 p.m., then midway between Sunk and Long Sand. While out the wind rose to a heavy gale and sea running very high, and a great deal of spray blowing off the crest of the waves. We then tried

her all ways against the wind and sea, and manœuvred with the rudder and water-jets, and she behaved admirably. We then returned to Harwich with the full force of the gale and sea against her, and she made splendid headway. We arrived at Harwich 3 p.m.

October 20, 1890.—Gun fired 3.45 a.m.; under way 4.15 a.m.; proceeded to sea; took Reserve Boat No. 3 in tow off Andrew's Buoy. Spoke Cork Lightship 4.45 a.m. Received orders to go to Shipwash Sands to a ship in distress thereon. We went straight to the sands, and found the *s.s. Achilles*, of Sunderland, bound from Riga to London, with railway sleepers. We arrived alongside of her at 5.35 a.m., and landed men aboard, who started heaving out her cargo at once. We steamed round her, and took soundings, wind blowing from N.W. There was a heavy sea running on the sand. We towed on her for about an hour and a half before high water, and broke two $4\frac{1}{2}$ inch hemp ropes, and then took a 20 inch hawser off the tug *Harwich*, and kept about 20 fathoms quite taut. She came off at high-water, 4 p.m. The steam lifeboat surprised everybody in keeping the tug's hawser taut, as remarks were passed that she could not hold it out of the water; but she did, and kept it taut too. We then took Reserve Boat No. 3 in tow, and returned home, arriving at Harwich at 6 p.m., everything having gone well during service rendered to save ship and crew, numbering 21.

October 24, 1890.—Gun fired 3.5 p.m. Proceeded to sea 3.35 p.m. Took Reserve Boat No. 3 in tow off pier end. Spoke Cork Lightship 4.5 p.m., and were informed that H.M.S. *Hearty* was ashore on Cutler Sand. We sighted her, and proceeded towards her; but she had got off the sand without any assistance, and was proceeding on her voyage. She came off without any assistance, as the weather was fine, and a flood tide when she went on. We returned to Harwich at 6 p.m.

November 7, 1890.—Received orders from chief officer of Coastguard to proceed to sea on a trial, as there was a gale blowing from N.W. We left Harwich 9.40 a.m., passed Cork Lightship 10.10 a.m., and went off below Sunk Lightship, towards Long Sand, and tried her all ways against sea and wind. There was a tremendous sea running, and blowing a heavy gale from N.W. She behaved splendidly, and took no heavy water over whatever, but a great deal of spray. We then returned to Harwich, and arrived at 2 p.m.

November 13, 1890.—Gun fired 9.30 a.m.; fires lit 9.35 a.m.; under weigh 10.10 a.m. Took Reserve Boat No. 3 in tow in the harbour, and proceeded direct to the Sunk Lightship. They were still firing their guns when we sighted them, and were flying signals of distress. We spoke them, and they told us there was a ship ashore on the Long Sand. We proceeded there, and arrived alongside the ship in distress at 12.50 p.m., and found the barquentine *Christine Elisabeth*, of Haugesund, derelict, the

crew having been taken off by a pilot cutter. We then steamed to the cutter, and took the captain and mate aboard of us, and then went back to the wreck, and put them and our crew aboard, who pumped her out. We then took soundings for getting her off, and laid by her till midnight, when she came off at high-water. We then returned to Harwich, but got fog-bound at 2 a.m., and lay to until 6 a.m., when the fog lifted. We proceeded on our journey to Harwich. We had Pilot Cutter No. 8 in tow from the Cork Lightship as far as Harwich. On arrival there, we took the remainder of the crew out of the pilot cutter, and put them aboard their ship. Arrived Harwich 8 a.m., 14th November, 1890. All went well while assisting to save ship and her crew.

November 25, 1890.—Received orders from chief officer of Coastguard to proceed to sea on a trial trip, wind blowing from N.E. Proceeded to sea 8 a.m., and went below Cork Sand towards Shipwash Sand, and tried circles ahead and astern with rudder and water jets, and rudder only and jets only; she gave every satisfaction. We threw a life-buoy overboard, and were able to round it and pick it up with the greatest of ease. We then returned to Harwich 12.30 p.m.; the sea was rough while we were out.

November 28, 1890.—Gun fired 12.10 p.m.; we steamed round and took Reserve Boat No. 3 from her berth, and then proceeded to sea at 12.30 p.m., Spoke Cork 1.5 p.m.; received orders to go to a ship in distress on the Whiting Sand. We arrived at the sand 2.30 p.m., and steamed all round, but could not see anything left of the ship; she went to pieces as soon as she struck. There was a N.E. gale blowing and a very high sea running, and a severe snow-storm. We returned to Harwich, and arrived 7 p.m.

November 29, 1890.—Gun fired 3.30 a.m. Steamed round and took Reserve Boat No. 3 from her berth; proceeded to sea 3.55 a.m.; spoke Cork Lightship 4.30 a.m., and were told that Sunk Lightship had fired their guns for assistance; we went to them and spoke them 5.50 a.m., and were told that they had seen a large flare on the east side of Long Sand at 3.15 a.m. which looked like a flare for assistance. We then steamed on in that direction, but could not see any lights; we fired signals from both boats, but got no reply. We then steamed round about the sands till daylight, and not being able to see anything then, we returned to Harwich, arriving at 12.30 p.m. There was a N.E. gale blowing all the time we were out, and a very heavy sea running.

December 10, 1890.—Received orders from Chief Officer of Coast Guards to proceed to sea on a trial, fresh breeze blowing from E. Left moorings 9.30 a.m.; went down below between Cork and Shipwash Sands, and manœuvred the boat under sail, without steam; there was a fresh breeze blowing from N.E. and a moderate sea. We returned to Harwich, and arrived at 3 p.m.

December 23, 1890.—Received orders from chief

officer of Coastguard to proceed to sea on a trial, as there was a strong breeze blowing S. by S.W., and a heavy sea. We left Harwich 9 a.m. and went towards Sunk Lightship, and tried the boat in different ways, and made circles ahead and astern. We went alongside Cork Lightship and brought off some letters; we returned to Harwich 3.30 p.m.

N.B.—Every time we have launched, either for service or exercise, we have got away without any delay of the boat or machinery; we never have required to ease or stop the engines once under weigh. My opinion, and that of the crew, who have had great experience in rough weather on this coast, is that the boat has been fairly tried, for they have not missed any opportunity of trying the boat; if we have not been summoned out on service in rough weather, we have been sent out on trials. The weather has been worse on this coast this year than has been known for some years. All service and exercise trips have been carried out with every satisfaction, and the boat has proved herself equal to any seas she has been out in yet. The crew say she is a splendid sea-boat, and they like her very much; the same remark has been passed by all those who have seen her at sea. When she was tried under sail alone, she gave very satisfactory results; 26 hours is the longest stretch she has been under steam as yet.

A. SIMMONS, *Chief Engineer.*

I have read this over to Coxswain Superintendent Tyrrell to see that my reports are correct, and he has signed accordingly.

W. TYRRELL,
Coxswain Superintendent.

The action of our own Royal National Lifeboat Institution in adopting this new departure in lifeboats has, as is only natural, awakened a lively interest in the subject amongst our neighbours abroad, and most of the Continental lifeboat services have asked to be furnished with full particulars of the boat; and though it is self-evident that such a lifeboat as this can only be successfully worked from some sort or kind of harbour, there is no doubt that steam having now obtained a footing in lifeboat work will soon become a powerful factor in this most important branch of marine institutions.

In conclusion, I would wish to acknowledge the great advantages we have gained from the hearty co-operation of the National Lifeboat Institution. They have never spared themselves in either time or labour, and have always been ready and anxious to place their great practical experience at our disposal.

Nothing in the boat has been taken for granted; but everything has been tested by their own officers, which of course involved

numerous trials and alterations, but eventually produced a boat where every detail had been passed and proved by practical lifeboat authorities, and they were consequently enabled to place the boat on one of their most dangerous stations without any misgivings as to the result.

DISCUSSION.

Mr. J. I. THORNYCROFT said his firm, before constructing the machinery for this boat, devoted considerable time to working out all the details. It was believed that hydraulic propulsion was not nearly so good as that by a screw; but, as Mr. Green had pointed out, where you had to work in very rough water, there were great drawbacks to the use of the screw. He would not express an opinion as to whether hydraulic propulsion was the best that could be used in the case of lifeboats. With regard to the intake of water, the usual method had been to take it in at right angles to the motion of the vessel, but this involved a considerable waste of power. The break in the bottom of the boat at first sight appeared to be a curious feature; but when one examined the line drawing of the vessel, it would be seen that the vessel had a certain increase of section at the water inlet, and the important feature was that you had a continuous flow. The boiler had been designed for great lightness, which was of great importance, as the vessel was likely to encounter rough seas, and as much of the gross weight of the vessel as possible should be devoted to making the hull strong. Another great advantage in the boat was said to be that no communication was necessary with the engine-room for altering the course, but he thought it would be an advantage if means could be adopted for relieving the engines when the boat was waiting about, instead of continuously driving at full speed. The general design of the boat resembled very much what the Lifeboat Institution had found in practice to work well in ordinary boats, and he considered they had done wisely in adopting this form, though he should prefer to see the length slightly increased, believing that it was a waste of power to have a boat so short. One great advantage in the boilers was the short time they took to get up steam, namely, twenty minutes for 100 pounds pressure, though, of course, the boat could start with considerably less pressure. He had heard it stated that forced draught was not suitable for long service, but this he thought was a mistake. When machinery was properly constructed for forced draught, it could be used for any length of time. If economy was desired, of course the draught must not be forced. For 450 revolutions, the amount of coal consumed, as compared with the machinery, was rather great, but if the power was reduced one-half, the boat would not lose very much speed, while there would be a very great saving in the consumption of coal.

Capt. the Hon. H. W. CHWTYND, R.N., said he did not think he could add much to what Mr. Green had said, as he had given a most temperate and moderate description of the boat and her doings. The boat had proved herself, so far, in every way capable of doing what had been expected. One point which it was desirable should be known was that, although this promised to be a complete solution of the difficulties of one part of the lifeboat service, he did not see that it held out any hope, as yet, of mechanical propulsion for lifeboats in general, because the weight and size were prohibitory to its use with ordinary boats. There were four descriptions of boats:—(1) Those that went out from a harbour to outlying sands; (2) those launched from the open beach to go to outlying sands; (3) those launched down shipways to go to outlying sands, or for wrecks on the main shore; and (4) those launched from transporting carriages, on which they were taken to the most advantageous point for launching, to reach a wreck on the main shore. About four-fifths of the whole of the boats of the Lifeboat Institution came within the last class. In them weight was a point which it was absolutely necessary to keep down, so that anything in the shape of steam was quite prohibitory. The same remark equally applied to the third and second class. The first class was the only one to which as yet steam was applicable, or promised to be applicable. Weight was not the only thing to be considered; there was also the absolute necessity, when launching, of keeping the boat end on to the sea, and gathering a certain amount of way immediately she touched the water. This was better attained by means of oars than by any steam machinery. If the boat were at this time thrown broadside on the launch would be a failure. With regard to the suggestion of Mr. Thornycroft, that the boats should be made longer, he might observe that the vital point in lifeboat work was the great convenience in manœuvring, not only in going alongside a wreck, but among breakers, where it might be found necessary to suddenly put the boat end on to one, and in order to do this it was necessary to keep the length down as much as possible. He differed with Mr. Thornycroft as to the advisability of the engines not going full speed. The whole manœuvring of the boat depended on the two handles; if you slackened speed, the quantity of water discharged was reduced, and of course the power of manœuvring was more or less diminished. The Lifeboat Institution was much gratified with the result which had been achieved by this boat, and for leaving harbours he had no doubt they would prove a success.

Mr. A. RECKENZAUN, who had made the propulsion of boats by means of electricity a study for some time, said he noticed that Mr. Green stated that the weight of the accumulators was one ton per h.p., but this was rather an exaggeration, it should be 1½ cwt. per h.p. hour. He believed that in special where great speed was not necessary, electricity

might have a fair trial with storage batteries, as they would take up very little space, and could be used as ballast at the bottom of the boat, thus leaving the whole boat free for the purpose of carrying passengers. Instead of carrying 30 persons, a boat of the same size as that described would, if storage batteries were used, probably carry over 100 persons. Another advantage was that an electric-motor did not race; the speed would be constant, as the current used varied in accordance with the power applied. Again, there would be no necessity to get up steam before starting, the only difficulty being the re-charging of the accumulators when they became exhausted, but this could be done by the erection of a steam-engine near the lifeboat house. He did not think the knowledge of electricity had, as yet, arrived at such a state that electricity could be used as a means of propulsion for lifeboats, but he had no doubt whatever that some scheme would be eventually devised for accomplishing this object.

Mr. J. CORBETT said he had made the subject of propelling lifeboats by steam a study for some time past, and had read a paper before the Naval Architects upon the subject of "Experiments with Lifeboat Models." He had also prepared a design in draft, but, having had time to think it over, he was glad he did not send it in, if the boat now before them was to be one of the competitors, for that so completely met all the requirements that it must have been the winning design. The adoption of the hydraulic propeller was a perfect success for its purpose. He felt some doubt about it on first seeing the model, but, after reading the accounts, he did not feel the slightest doubt that it was far superior to any form of screw, even the special protected forms and tapering screws which were meant to free themselves from wreckage. No doubt the hydraulic propeller was wasteful of power, but when you said that you had said all that it was possible to say against it. He was rather inclined to cavil at the statement that this was the "successful termination" of the question of how to apply steam to lifeboats; and considered it would have been more appropriate to say the "successful commencement." He must say he had never met with any committee that was so patient in investigation as that of the Lifeboat Institution. He considered the committee an honour to the nation. Dealing with the model before them, the points which struck him as requiring further improvement were, first, the short funnel, and next, the intakes for air. The funnels were so short that the crests of the waves would go over them, and the water, if it reached the fire, might cause mischief; and the intakes for air were so close to the deck, that they would certainly receive the heavy wash of the sea. These were the chief defects in the design, but he had no doubt they might easily be remedied. The air should be taken in through a funnel as high as the one from which it was sent out. Special protection ought to be given to the inlet and outlet funnels, so that when a splash

of water came down them it did not reach the boiler or stokehole; it should go down to a relief-hole at the bottom of the vessel. He would suggest a ball-valve at the bottom, that the connecting flue from the boiler into the vertical funnel should be turned from the boiler at a high level, and in a downward direction, and with a rising valve in it, so that the water should be prevented from entering the boiler. The same arrangement would apply to the intake of air. The air propeller, or fan, could draw from a receptacle in the midst of a vertical pipe reaching from the boat's bottom to a top like a funnel, drawing air from the top, and discharging any water at the bottom. The question of forced draught was, to his mind, one of very great importance, as in a lifeboat the funnels would often be lower than the crests of the waves, and, consequently, it had to encounter very violent eddies of wind. The draught would be reversed by the strong wind currents if there was not a strong forced draught. The boat practically depended on its steam power alone, but, in service, the boat in many cases had to go from deep to shallow water on the shore, where it must beat to windward to escape shipwreck. If the steamer got into difficulty with a lee shore, it could not beat off under sail, as its whole power depended on machinery. This was all very well in its way, but it would be a reasonable safeguard to put the whole of the machinery and boiler in duplicate, in case any one portion got out of order. He also thought the machinery too complicated for its purpose. If the object was to win a race, he could understand having splendid machinery with the elaboration of boilers, but the work of the boat on service would be more like that of a North Sea trawler, or fish-boat, and seafaring men preferred a very simple class of machinery. Another trifling matter was the form of the hull. They had no cross-section of the boat, so that the peculiar form could not be seen, but the model showed there was an overhanging fender. He thought for rough water it would be better to follow the model of an ordinary torpedo boat, somewhat shortened. The steam lifeboat has an S curve above the water line, so that when heeled over by a wave it would present a hollow surface to the next wave. He should be glad to be informed what was the utmost stability of the boat. No doubt the steamer would be very useful for towing purposes. He hoped the Institution would keep this boat continually afloat among the other boats that were to be tried next April, in order that its comparative merits might be ascertained. The vessel had certainly solved the problem of the practicability of steam lifeboats, and he took a more hopeful view than Captain Chetwynd as to the value of steam lifeboats in the future, believing that an engine of very small weight could be used which would be more efficient than ten oars. He observed it was described as "Green's Patent Lifeboat;" but he hoped that it was not "patent" in the sense of restriction, but that it would be free for public use.

Mr. SYDNEY BARNABY thought Messrs. Green were to be congratulated upon being the first to produce a steam lifeboat. It was no doubt a difficult problem, with which many people had been struggling for years. He believed that if ever hydraulic propulsion was justified, it was in this boat. There were many difficulties to be met with in the use of a screw or paddle-wheels, but here these difficulties had been overcome. No doubt it was true that the electrical motors would not race, but that was only one of the difficulties. If the screw was out of the water, no headway was made, and, therefore, a screw was not practicable. Taking the weight of the electrical motor at $1\frac{1}{2}$ cwt. per horse per hour, which was a lighter estimate than he had heard of before, it must not be forgotten that the boat might be out for 30 hours, and, therefore, if the $1\frac{1}{2}$ cwt. had to be multiplied by 30, it would be apparent at once that it would be impossible to put such a weight in a boat of this size. The greater the power you got into the boat the safer it would be, and this was one of the matters that had been considered by Mr. Green and Captain Chetwynd. Mr. Corbett had objected to the engines as being too complicated; no doubt they appeared to be so, but, on a careful examination, it would be found that they were not so. The engines were necessarily compound and surface-condensing, but the boiler was a very simple one to work; and one valuable thing about it was, that it could not explode. The height of the funnels, and the danger of getting water down them, had been a matter of serious consideration; but it must not be forgotten that it was a wide boat, and, being comparatively light, was easily moved by the waves. The fact was, that water did not go over the funnels; spray might go over them, but this would not cause any harm. There was no insuperable difficulty in making arrangements to prevent water which might get down the funnels from putting out the fires. But the trials which the boat had already undergone were a good justification for saying that the supposed danger did not exist. In the drawing the cowls were shown the wrong way, the opening should be aft.

The CHAIRMAN said it seemed quite clear that the mechanical propulsion of lifeboats was an established success, from the favourable reports made by those who had charge of this boat, especially when one remembered that sailors are naturally disinclined to pronounce any mechanical contrivance a success until they have been almost convinced against their will. It was unusual, in his experience, to see such favourable reports by practical seamen of a mechanical invention as had been given of this boat. As one or two remarks had been made about the workmanship, he might say that, in connection with such a boat, good workmanship was all-important. It was not only important that the hull should be above suspicion, but the machinery must be of the very best possible design and construction, so that there should not be

the slightest risk of a breakdown. Not only had the principle of mechanical propulsion been made a success in connection with lifeboats by this vessel, but also the principle of hydraulic propulsion was now likely to become practicable, it was likely to be thoroughly tried and tested, and the advantages and disadvantages of the system, and the circumstances under which it would compare favourably with others, were likely to be more thoroughly determined than ever they had been before. In conclusion, he begged to propose a hearty vote of thanks to Mr. Green for his interesting paper.

The vote of thanks was unanimously accorded, and the meeting adjourned.

Miscellaneous.

SUGAR PLANTING IN DEMERARA.

The United States Consul in Demerara, in his last report upon the agriculture of British Guiana, says that a sugar estate is divided into fields of from five to ten acres in extent by cross canals, and the method of planting the cane is simple and easy when labour is at command. The brushwood and grass having been cut down and weeded, are piled into rows six to eight feet apart across the intended beds into which the field is to be divided. These beds are found by digging open small drains two feet wide and two feet deep, at intervals of every thirty or thirty-six feet across the entire field, beginning within a few yards of the canal in the centre of the estate and running to the side draining trenches, into which they empty themselves. The soil from these small drains having been carefully thrown upon the beds, so as to raise and round them off the middle, narrow banks or ridges of earth are made across them from drain to drain, parallel to, and equidistant between, the rows of brushwood and grass, and in these spaces between the banks of earth and grass, the canes are planted in line, each line being three or four feet apart, and each cane plant nine or ten inches from the next. The plants are produced by cutting off the tops or upper joints of growing canes into lengths of ten or twelve inches, which are thrust, in a slanting direction, into the well-stirred ground, and, in about ten days, the long, grass-like leaves begin to spring from the eyes at every joint. These young canes require to be kept well weeded and free about the roots from the ridges of earth or decaying grass on either side of them, which had been previously prepared for that purpose, and this must be repeated as long as there is room for the labourers to pass between the rows, which, according to the season, will be until the plants have reached the age of six or eight months, after which time the

spreading of numerous leaves from each stock will have covered the surface of the field with so dense a jungle as in a great measure to prevent any further growth of weeds. When about nine months old, the cane throws out its "arrow," a long, seed like stem, surmounted with a tuft of waving, downy blossom. At this period the plant is poor and weak, and little more than a mass of water. It soon, however recovers, and in twelve or thirteen months from the time of planting, is considered at maturity, having then sometimes attained a height of twenty to twenty-five feet, but more frequently of ten to twelve feet, about as thick as the wrist, and divided into joints like a bamboo. When ripe, the canes are cut down to the ground in lengths of three or four feet, and thrown into punts which are towed along the canal, by mules or oxen, to the wet dock at the door of the sugar mill. Immediately after cutting, the large quantity of "trash," or dry leaves is rolled clear of the cane stump and heaped in rolls, there to decay and form a rich manure for the succeeding crop. In a few days the stumps throw out their shoots, and the same routine of cultivation is repeated for twelve months more, any vacant space where plants may have missed, being carefully supplied. The canes of the first year are called "plant canes," those of the second and subsequent years being distinguished as "ratoons;" and these ratoons have been known to be reproduced from the first plant for twenty years and upwards, the cane having been annually cut down and the stumps allowed to shoot again. This continued reproduction, however, from the same stock, causes the cane to degenerate and to yield less abundantly. An acre of newly-planted land will give two tons of sugar for the first year, gradually falling off to not more than one fourth of that quantity, as the stocks become old; and it is said that, if there were sufficient labour in the colony to admit of the land being replanted every third or fourth year, there can be little doubt that the present crop would be nearly doubled. Of the implements used, the principal are the shovel, the hoe, the cutlass, and the fork. Of several patterns of the shovel—or shovel-plough, as it is sometimes called—the shape of that known as the "Demerara shovel," is convex on the back, and concave on the front or upper sides; in other words, a section of a hollow cylinder with a socket attached for the long wooden handle to be inserted, unless in actual use. A variety of this article, known as the "shovel spoon," is also used for special purposes, differing from the ordinary shovel chiefly in being of greater convexity, rendering the transverse diameter proportionately shorter, the length also being somewhat less, and the lower corners rounded. The cutlass, or *machete*, has a blade from eighteen to twenty-two inches in length, with a socket handle of four and a half to five inches, in which a longer wooden handle may be inserted if necessary, though this is rarely used. The blade is about one inch and three quarters in width near the handle, widening to two inches and three quarters or

more toward the point, in approaching which, the cutting edge, nearly straight throughout the greater part of its length, rapidly curves, giving the whole implement some resemblance to the Malay *kris*, though longer, thinner, and lighter. It is used for cutting canes, and besides its legitimate uses it becomes a dangerous weapon in the quarrels which sometimes occur among the coolies.

THE RAILWAYS OF COLOMBIA.

The Republic of Colombia has a population of 4,000,000 inhabitants, with an extent of territory of 504,773 square miles. The population is densest along the Atlantic coast, and especially in the interior of the country in the high regions, where the climate is mild and healthy, and the soil suitable for agriculture. The highway for communication with the exterior is the River Magdalena, which waters seven of the nine departments into which the Republic is divided, and empties into the Atlantic through the two mouths Ceniza and Rio Viejo. The Magdalena is navigable for small vessels from a little below Honda to Barranquilla. This part of the river is called Lower Magdalena. In the dry season its waters diminish greatly, rendering navigation difficult and even dangerous, at least between Honda and the point called Nare. The Upper Magdalena, that is to say from Honda to its source, is also navigable to a great extent (between Honda and Neiva), but there the scarcity of water during a large part of the year is still more noticeable, which renders navigation very irregular and dependent upon circumstances. The Colombian delegate to the recent International American Railway Conference says in his report upon Colombian Railways, that the Magdalena being the principal highway of Colombia, and traversing the richest and most populous departments, it is easily understood that the tendency there has been to connect this river with the principal centres of production and consumption. For this reason there is nothing in Colombia corresponding to a railroad system; the existing lines, those under construction, and those contemplated, are all short, isolated, and independent. From the first, the need which was most urgently felt there was that of communication between the capital of the Republic, Bogota, and the Magdalena. With this in view, the construction of a railroad was commenced which was to connect Girardoh, a port on the Upper Magdalena, a little above Honda, with the table land on which Bogota is situated (9,000 feet above the sea level). Of this road some 40 kilometres are already constructed, and there remain about 45 more to be built to connect it with the railroad on the plain of Bogota, between that city and Facatativa, at the branch line running southward towards the aforesaid railroad of Girardoh. The part of this

work yet to be finished is relatively the most difficult and expensive, since it must ascend the Cordillera, which is very high and steep. The Antioquia Railroad starts from Puerto Berrio, on the Magdalena, and runs to Medellin, the capital of the rich and densely populated department of Antioquia. Fifty kilometres of the most difficult and expensive portion have been constructed. This railroad belongs to the Government of the department, which is disposed, says M. Martinez Silva, to make very liberal offers for its completion. M. Silva adds that it would be an excellent investment for foreign capital. Another very important line, and one which is expected would yield large dividends, would be the one which would connect the city of Bucaramanga with the River Magdalena. Bucaramanga is the capital of the rich and industrial province of Santander. It is one of the most prosperous cities of the Republic, and is the centre of a region which produces large quantities of excellent coffee. The road would be a short one; it has been accurately surveyed, and it is stated that its construction offers no great difficulties. Another line of railroad is that which runs from Barranquilla on the Magdalena to Prieto Colombia on the Atlantic, which is the place where at the present time there is the largest export and import trade. The best ports of Colombia on the Atlantic are Cartagena and Santa Marta, but the latter city, once very important on account of its communication with the Magdalena, has eventually become cut off from it. An attempt is now being made to re-establish this communication by means of a railroad, of which 45 kilometres have already been built. It is under the direction of a private company, supported by European capital. Those railways enumerated above are the ones which communicate with the Magdalena. Completely independent of these are three others—that of Panama, which crosses the Isthmus between Colon and Panama; that of Circuta, between that city on the frontier of Venezuela and the River Zulia, by which is exported all the coffee of that part of Colombia and the neighbouring States of Venezuela; it is 55 kilometres long, and is an excellent line, constructed with native capital and by native engineers; that of Cauca, starting from the port of Buenaventura and running to Cali, a very important city of the highly fertile valley of the Cauca. Of this line, 21 kilometres have already been laid, and a European company has recently taken charge of its completion. M. Silva says, in conclusion, that what Colombia most needs at the present day is to construct or finish lines connecting Bogota, Bucaramanga, and Medellin, with the Magdalena. A railroad which would ascend this river from Cartagena to Bogota would obviate all the difficulties of that slow and uncertain navigation. The work would not present serious difficulties of engineering, and would rapidly open up the immense tracts situated along the river, which are exceptionally fertile and rich in all kinds of woods and vegetable products.

Notes on Books.

COLOUR IN WOVEN DESIGN. By Roberts Beaumont. London: Whittaker and Co. 1890.

The object of this work, as stated by the author himself in his preface, is to supply as far as possible a complete scheme of textile colouring, and to demonstrate the methods of applying fancy shades to all descriptions of woven manufactures. After a few words on the subject generally of the application of colour to woven fabrics, Mr. Beaumont proceeds to the question of colour itself, and devotes his first chapter to an explanation of the elementary principles of light and colour. For the purpose of his book he is content to regard red, blue, and yellow as primaries, though he is careful to explain that the reason for which they are so called is incorrect. Such matters as colour combinations and colour contrasts are then discussed, but always with an eye to the special purpose of the book. Having cleared the ground by supplying this elementary information, the author proceeds to the more purely technical part of his subject, the analysis of woven pattern, and the description of all the means by which it may be obtained. This is treated very fully and at considerable length, the explanations being supplemented by copious illustrations in colours, these indeed forming the important feature of the book.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

JANUARY 21.—A. G. GREEN, C. F. CROSS, and E. J. BEVAN, "Photography in Aniline Colours." CAPT. ABNEY, C.B., F.R.S., will preside.

JANUARY 28.—CARMICHAEL THOMAS, "Illustrated Journalism." LUKE FILDES, R.A., will preside.

FEBRUARY 4.—J. EMERSON DOWSON, "Decimal Coinage, Weights, and Measures." SIR HENRY E. ROSCOE, M.P., F.R.S., will preside.

FEBRUARY 11.—SIR ROPER LETHBRIDGE, M.P., "The Proposed Irish Channel Tunnel." The DUKE OF ABERCORN, C.B., Vice-President, will preside.

FEBRUARY 18.—COL. SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S. "Methods and Processes of the Ordnance Survey." The ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

FEBRUARY 25.—E. J. RAVENSTEIN, "Colonisation and its Limitations."

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock :—

FEBRUARY 17.—COMMANDER V. LOVETT CAMERON, C.B., "Chartered Companies in Africa."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

The meeting announced for January 20th has been postponed.

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

JANUARY 22.—EDWARD J. WATHERSTON, "Hall-marking of Silver Plate, with special reference to India." SIR THEODORE CRACRAFT HOPE, K.C.S.I., C.I.E., will preside.

FEBRUARY 26.—ROBERT GORDON, M.Inst.C.E., "The Economic Development of Siam." SIR CHARLES EDWARD BERNARD, K.C.S.I., will preside.

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. the LORD REAY, G.C.S.I., G.C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

JANUARY 27.—WILLIAM SIMPSON, "Lithography: a finished chapter of Illustrative Art." SIR JAMES D. LINTON, P.R.I., will preside.

FEBRUARY 10.—HEYWOOD SUMNER, "Sgraffito." CHARLES BARRY, F.R.I.B.A., will preside.

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

CANTOR LECTURES.

The following Courses of Cantor Lectures will be delivered on Monday evenings at Eight o'clock :—

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

LECTURE I.—JAN. 26.—Introduction—Division of subject—Importance of the Violin family—The Violin, Viola, Violoncello—The Double Bass—The beauty and varnish of Cremona Violins—The chest of Viols, Viola da Spalla, Viola da Gamba, Viola d'Amore—Modern commercial manufacture of the Violin—The Harp, the Guitar, Bandurria and wire-strung Guitar or Zither—The Mandolines, the Lute, Archlute, Theorbo, Chitaronne.

LECTURE II.—FEB. 2.—Wind Instruments—Recent date of modern orchestra—Improvements of Wind Instruments in the present century—The Wood Wind: Flute, Oboe, Bassoon, Clarinet—Characteristic tone quality not due to material em

ployed—Boehm's Flute—Seventeenth century family of Recorders—The Oboe and Bassoon Reed—Its antiquity—Difference of cylindrical and conical tubes—Seventeenth century family of Oboes—The Oboe di Caccia, Oboe d'Amore, Cor Anglais—The Sarrusophones—Seventeenth century family of Cromornes—The Bagpipes; Syrian Scale—The Clarinet, acoustic peculiarity—The Clarinet Reed—The Basset Horn and Bass Clarinet—The Saxophones—The French Horn—Valves or Ventils—The Trumpets and Trombones—Bach's Trumpet parts—Seventeenth century family of Cornets or Zincken—The Serpent, Basson Russe, Ophicleide—The Tubas and Saxhorns—Euphonium—Bombardon—Contrabass—Cause of modern rise in pitch.

LECTURE III.—FEB. 9.—Instruments grouped by the adaptation of a Keyboard—Its service to composition—History of the Keyboard—The early Organ—The Drone—Drawings of early portable Organ Keyboards—The Cantigas de Santa Maria—Keyboards in Italian and Flemish paintings—Summary of early large Church Organs from Praetorius—The long measure bass—The short measure or short octave—The mixture—Its dissection into registers—The pedal Keyboard—Sketch of a complete Organ—The Regal—The Harmonium and American Organ—The Echiquier and the precursors of the Piano—The Pianoforte.

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

February 16, 23; March 2.

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

March 9, 16, 23.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 19.—Surveyors, 12, Great George-street, S.W., 8 p.m. Prof. J. Wrightson, "The Basis of the Cost of Wheat-growing."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Alexander Buchan, "The Meteorological Results of the Challenger Expedition in relation to Physical Geography."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. London Institution, Finsbury-circus, E.C., 5 p.m. Mr. E. L. S. Horsburgh, "Social Questions in the Middle Ages."

TUESDAY, JAN. 20.—Royal Institution, Albemarle-street, W., 5 p.m. Prof. V. Horsley, "The Structure and Functions of the Nervous System." (Part I.) "The Spinal Cord and Ganglia."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. W. H. Allen, "Auxiliary Engines in connection with the Modern Marine-Engine."

Statistical, 28, Jermyn-street, S.W., 7½ p.m. Inspector-General Robert Lawson, "The Operation

of the Contagious Diseases Acts, from their Introduction in 1864 to their ultimate Repeal in 1886." Pathological, 20, Hanover-square, W., 8½ p.m. Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. F. E. Beddard, "A Species of Earthworm of the Genus *Siphonogaster* from West Africa." 2. Mr. Oswald H. Latter, "Notes on *Anodon* and *Unio*." 3. Mr. Roland Trimen, "Butterflies collected in Tropical South-western Africa by Mr. A. W. Eriksson." 4. Mr. H. H. Brindley, "A Specimen of the White Bream (*Abramis blicea*, Bloch) without Pelvic Fins."

WEDNESDAY, JAN. 21.—SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Messrs A. G. Green, C. F. Cross, and E. J. Bevan, "Photography in Aniline Colours."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Robert H. Scott, "Note on a peculiar development of Cirrus Cloud observed in Southern Switzerland." 2. Col. W. F. Badgley, "Some Remarks on Dew." 3. Annual General Meeting, Report of Council, &c.

Geological, Burlington-house, W., 8 p.m. 1. Prof. H. G. Seeley, (i.) "*Agosaurus macgillivrayi* (Seeley), a Saurischian Reptile from the north-east coast of Australia." (ii.) "*Sauromedon Robertsoni*, a Crocodylian Reptile from the Trias of Linkfield in Elgin." 3. Prof. J. Prestwich, "The Age, Formation, and successive Drift Stages of the Valley of the Darent; with remarks on the Palæolithic Implements of the District, and on the Origin of the Chalk Escarpment."

Microscopical, 20, Hanover-square, W., 8 p.m. Annual General Meeting. President's Address.

Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting. Address by the President, Lord Walsingham.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Adjourned discussion on Mr. Ellis's paper, "The Doctrine of Equivalents, Mechanical and Chemical." 2. Mr. A. V. Newton, "The Teaching of the Law Courts."

Civil and Mechanical Engineers, Westminster Palace Hotel, S.W., 7 p.m. Mr. R. Capper, "The Engineer and his Workmen."

THURSDAY, JAN. 22.—SOCIETY OF ARTS, John-street Adelphi, W.C., 4½ p.m. (Indian Section.) Edward J. Watherston, "Hall-marking of Silver Plate, with Special Reference to India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. S. J. Hickson, "Animal Life on a Coral Reef."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Hall Caine, "The Little Manx Nation."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Major-Gen. C. E. Webber, "The Distribution of Electricity, with Special Reference to the Chelsea System."

FRIDAY, JAN. 23.—Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Lord Rayleigh, "Some Applications of Photography."

Philological, University College, W.C., 8 p.m. Dr. J. A. H. Murray, "A Dictionary Evening."

Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, JAN. 24.—Potanic, Inner Circle, Regent's-park, N.W., 3½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Martin Conway, "Pre-Greek School of Art."

Journal of the Society of Arts.

No. 1,992. VOL. XXXIX.

FRIDAY, JANUARY 23, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

POPULAR AFTERNOON LECTURES.

The Council have arranged for a course of five popular lectures to be given by CAPTAIN W. DE W. ARNEY, C.B., D.C.L., F.R.S., on the following afternoons, at half-past four o'clock—February 13, 20, 27, March 6, 13. The subject will be "The Science of Colour." The lectures will be of a popular and elementary character, and will be fully illustrated by experiments.

The regulations for admission will be the same as for the Cantor Lectures, each member having the privilege of admitting one friend.

Proceedings of the Society.

CANTOR LECTURES.

GASEOUS ILLUMINANTS.

BY PROF. VIVIAN B. LEWES.

Lecture V.—Delivered December 22, 1890.

Having now brought before you the various methods by which ordinary coal gas can be enriched, so as to give an increased luminosity to the flame, I wish now to discuss the methods by which the gas can be burnt, in order to yield the greatest amount of light, and also the compounds which are produced during combustion.

In the first lecture, whilst discussing the theory of luminous flames, I pointed out that,

in an atmospheric burner, it was not the oxygen of the air introduced combining with and burning up the hydrocarbons, and so preventing the separation of incandescent carbon, which gave the non-luminous flame, but the diluting action of the nitrogen, which acted by increasing the temperature at which the hydrocarbons are broken up, and carbon liberated; a fact which was proved by observation that heating the mixture of gas and air again restored the luminosity of the flame. This experiment clearly shows that temperature is a most important factor in the illuminating value of a flame; and this is still further shown by a study of the action of the diluents present in coal gas, the non-combustible ones being far more deleterious than the combustible, as they not only dilute, but withdraw heat.

Anything which will increase the temperature of the flame will also increase the illuminating power, provided, of course, that the increase in temperature is not obtained at the expense of the too rapid combustion of the hydrocarbons.

As has been shown in the experiments relating to the action of diluents on flame, already quoted, oxygen, when added to coal gas, increases its illuminating value to a marked and increasing degree, until a certain percentage has been added, after which the illuminating power is rapidly decreased, until the point is reached when the mixture becomes explosive. This is due to the fact that the added oxygen increases the temperature of flame by doing the work of the air, but without the cooling and diluting action of the nitrogen; when, however, a certain proportion is added, it begins to burn up the heavy hydrocarbons; and although the temperature goes on increasing, the light-giving power is rapidly diminished by the diminution of the amount of free carbon in the flame.

It has been proposed to carburet and enrich poor coal gas by admixture with it of an oxy-oil gas made under Tatham's patents, in which crude oils are cracked at a comparatively low temperature, and are there mixed with from 12 to 24 per cent. of oxygen gas. Oil gas made at low temperatures, *per se*, is of little use as an illuminant, as it burns with a smoky flame, and does not travel well, but when mixed with a certain amount of oxygen, it gives a very brilliant white light, and no smoke, whilst as far as experiments have at present gone its travelling powers are much improved.

At first sight it seems a dangerous experi-

ment to mix a heavy hydrocarbon gas with oxygen, but it must be remembered that although hydrogen and carbon monoxide only need to be mixed with half their own volume of oxygen to give a most explosive mixture, yet as the number of carbon and hydrogen atoms in the combustible gas increase, so does the amount of oxygen needed to give explosion. Thus coal gas needs rather more than its own volume, and ethylene three times its volume, to give the maximum explosive results, whilst these mixtures begin to be explosive when 10 per cent. of oxygen is mixed with hydrogen or water gas, 30 per cent. with coal gas, and over 50 per cent. of oil gas of the character used. It is claimed that if this gas was used as an enricher of coal gas, 5 per cent. of it would increase the luminosity of 16-candle gas by about 40 per cent.

Oxygen has been obtained for some time past from the air on a commercial scale by the Brin process; and at the present time there seems every prospect of our being able to obtain oxygen at a rate of about 3s. 6d. per 1,000 cubic feet. Another process by which this important result can also be obtained was first introduced by Tessié du Mothay, and has now just been revived. It consists of passing alternate currents of steam and air over sodic manganate heated to dull redness in an iron tube; the process has never been commercially successful, for the reason that the contents of the tube fused, and flowing over the surface of the iron rapidly destroyed the tubes or retorts, and also as soon as fusion took place, the mass became so dense that it had little or no action on the air passing over it. Now, however, this difficulty has been partly overcome by so preparing the manganate as to prevent fusion, and to keep it in a spongy state, which gives very high results, and the substance being practically everlasting, the cost of production is extremely low.

It is proposed to feed this by a separate system of pipes to small gas jets, and by converting them into practically oxyhydrogen blow-pipes, to raise solid masses of refractory material to incandescence, and also by supplying oxygen in the same way to oil lamps of particular construction, to obtain a very great increase in illuminating power.

Whether these methods of employing cheap oxygen would be successful or not, I do not wish to discuss at the present time, but there is no doubt but that cheap oxygen would be an enormous boon to the gas manager, as by

mixing 0.8 per cent. of oxygen with his coal gas before purification, he could not only utilise the method so successfully introduced by Mr. Valon at Ramsgate, but could also increase the illuminating value of his gas.

In speaking of the structure of flame, I pointed out that close to the burner from which the gas giving the flame is issuing, a space exists in which no combustion is going on—in other words, a flame is never in contact with the rim of the burner. This is best seen when the gas is turned low—with a bating burner, for instance—turned so low that only a small non-luminous flame is left, the space between burner and flame will appear as great as the flame itself, whilst, if the gas is mixed with an inert diluent like carbon dioxide, the space can be very much increased.

Several theories have been brought forward to explain this phenomenon, but the true one is that the burner abstracts so much heat from the flame at that point that it is unable to burn there, and this can be proved by the fact that where a cold object touches the flame, a dividing space, similar to that noticed between flame and burner, will always be observed, and the colder the object and the more diluted the gas the greater is the observed space. If a cold metal wire or rod is held in a non-luminous flame, it causes an extinction of the gas for some considerable space around itself; but as the temperature of the rod rises, this space becomes smaller and smaller until the rod is heated to redness, and then the flame comes in contact with the rod.

In the same way if the burner from which the gas is issuing be heated to redness, the space between burner and flame disappears. It has already been shown that cooling the flame by an inert diluent reduces the illuminating value, and finally renders it more luminous; and we are now in a position to discuss the points which should be aimed at in the construction of a good gas burner.

In the first place, a sensible diminution in light takes place when a metal burner is employed, and the larger the surface and thickness of the metal the worse will be its action on the illuminating power of the flame; but this cooling action is only influencing the bottom of the flame, so that with a small flame the total effect is very great, and with a very large flame almost *nil*.

The first point, therefore, to attend to is, that the burner shall be made of a good non-conductor. In the next place, the flow of the

gas must be regulated to the burner, as, if you have a pressure higher than that for which the burner is constructed, you at once obtain a roaring flame and a loss of illuminating power, as the too rapid rush of gas from the burner causes a mingling of gas and air, and a consequent cooling of the flame. The tap also which regulates the flame is better at a distance from the burner than close to it, as any constriction near the burner causes eddies, which give an unsteady flame.

These general principles govern all burners, and we will now take the ordinary forms in detail. In the ordinary flat-flame burner, given a good non-conducting material, and a well-regulated gas supply, little more can be done, whilst burning it in the ordinary way, to increase its luminosity; and it is the large surface of flame exposed to the cooling action of the air which causes this form of burner to give the lowest service of any per cubic foot of gas consumed. Much is done, moreover, by faulty fittings and shades, to reduce the already poor light given out, because the light-yielding power of the flame largely depends upon its having a well-rounded base and broad luminous zone; and when a globe with a narrow opening is used with such a flame—as is done in 99 out of 100 cases—the up-draught drags the flame out of shape, and seriously impairs its light-giving powers, a trouble which can be got over by having the globe with an opening at the bottom not less than 4 inches in diameter, and having small shoulders fixed to the burner, which draw out the flame and protect the base from the disturbing influence of draughts.

The Argand burner differs from the flat-flame burners in that a circular flame is employed. The air supply is regulated by a cylindrical glass, and this form of burner gives a better service than the flat-flame burner, as not only can the supply of gas and air be better adjusted, but the air being slightly warmed by the hot glass, adds to the temperature of the flame, which is also increased by radiation from the opposite side of the flame itself.

The chief loss of light in such a burner depends upon the fact that being circular, the light from the inner surface has to pass through the wall of flame, and careful photometric experiments show that the solid particles present in the flame so reduce its transparency, that a loss amounting to about 25 per cent. of light takes place during its transmission.

The height of the flame also must be care-

fully adjusted to the size of the flame, as too long a chimney, by increasing the air supply unduly, cools, and so lowers the illuminating power of the flame. Experiments with carburetted water gas gave the following results, with a consumption of 5 cubic feet per hour:—

Size of Chimney.		Height of Flame.		Candle-power.
6 × $1\frac{7}{8}$	.....	$2\frac{1}{2}$	.....	21
7 × $1\frac{7}{8}$	.....	$2\frac{1}{4}$	.....	21·3
8 × $1\frac{7}{8}$	.....	$2\frac{1}{8}$	.....	20·8
9 × $1\frac{7}{8}$	.....	$1\frac{7}{8}$	.....	18·2

For many years no advance was made upon these forms of burner, but when ten years ago it was recognised that anything which cools the flame reduces its value, whilst anything which increases its temperature raises its illuminating power, then a change took place in the forms of burner in use, and the regenerative burners, introduced by such men as Siemens, Grimston, and Bower, commenced what was really a revolution in gas lighting. By utilising the heat contained in the escaping products of combustion to raise the temperature of the gas and air which are to enter into combination in the flame, an enormous increase in the temperature of the solid particles of carbon in the flame is obtained, and a far greater, and whiter light is the result.

The Bower lamp, in which (at any rate in the later forms) the flame burns between a downward and an upward current of air, was one of the first produced, and so well has it been kept up to date that it still holds its own; whilst as types of the "inverted cone" regenerative burner we may also take the Cromarty and Wenham lights, which have been followed by a host of imitators, and so closely are the original types adhered to that one begins seriously to wonder what the use of the Patent-office really is.

The Schülke, and the last form of Siemens regenerative burner, however, stand apart from all the others by dealing with flat and not conical flames, and in both regeneration is carried on to a high degree. The only drawback to the regenerative burner is that it is by far the best form of gas stove as well as burner, and that the amount of heat thrown out by the radiant solid matter in the flame is, under some circumstances, an annoyance; but, on the other hand, we must not forget that this is the form best adapted for overhead burners, and that nearly every form of regenerative lamp can be adapted as a ventilating agent, and that with the withdrawal of the products of combustion from the air of the

room, the great and only serious objection to gas as an illuminant disappears.

When coal gas is burnt, the hydrogen is supposed to be entirely converted into water vapour, and the carbon to finally escape into the air as carbon dioxide; and if this were so every cubic foot of gas consumed would produce approximately 0.52 cubic feet of carbon dioxide and 1.34 cubic feet of water vapour, whilst the illuminating power yielded by the cubic foot of gas will of course vary with the kind of burner used.

Roughly speaking, the ordinary types of burner give the following results:—

Name of Burner.	Illuminating power in candles per c. f. of gas consumed.	Products of combustion per candle-power.	
		Carbon Dioxide.	Water Vapour.
Batwing	2.9	0.18 c.f.	0.46 c.f.
Argand	3.3	0.16 c.f.	0.40 c.f.
Regenerative	10.0	0.05 c.f.	0.13 c.f.

So that the regenerative forms of burner, by giving the greatest illuminating power per cubic foot of gas consumed, yield a smaller amount of vitiation to the air per candle of light emitted.

An ordinary room, say 16' × 12' × 10', would not be considered properly illuminated unless the light were at least equal to 32-candle power; and, in the Table below, the amount of the oxygen used up, and the products of combustion formed by each class of illuminant and burner in attaining this result, are given, the number of adults who would exhale the same amount during respiration being also stated.

From these data it appears, according to rules by which the degree of vitiation of the air in any confined space is measured by the amount of oxygen used up and carbon dioxide formed, that candles are the worst offenders against health and comfort. Oil lamps come next, and gas least. This, however, is an assumption which practical experience does not bear out. Discomfort and oppression in a room lighted by candles or oil are less felt than in one lighted by any of the older forms of gas burner; and the partial

AMOUNT OF OXYGEN REMOVED FROM THE AIR, AND CARBON DIOXIDE AND WATER VAPOUR GENERATED TO GIVE AN ILLUMINATION EQUAL TO 32-CANDLE POWER.

(The amount of light required in a room 16' × 12' × 10'.)

Illuminant.	Quantity of materials used.	Oxygen removed.	Products of Combustion.		Adults.
			Water vapour.	Carbon dioxide.	
Sperm candles	3,840 grains.	19.27 c.f.	13.12 c.f.	13.12 c.f.	21.8
Paraffin oil	1,984 „	12.48 c.f.	7.04 c.f.	8.96 c.f.	14.9
Gas (London)—					
Burners :					
Batwing	11 c.f.	13.06 c.f.	14.72 c.f.	5.76 c.f.	9.6
Argand	9.7 c.f.	11.52 c.f.	12.80 c.f.	5.12 c.f.	8.5
Regenerative	3.2 c.f.	3.68 c.f.	4.16 c.f.	1.60 c.f.	2.6

explanation of this is to be found in the fact that, when a room is illuminated with candles or oil, people are contented with a feeble and more local light than when using gas. In a room of the size described, the inmates would be more likely to use two candles placed near their books, or on a table, than thirty-two scattered about the room. Moreover, the amount of water vapour given off during the combustion of gas is greater than in the case of the other illuminants. Water vapour, having a great power of absorbing radiant heat from the burning gas, becomes heated,

and diffusing itself about the room causes great feeling of oppression; the air also being highly charged with moisture, is unable to take up so rapidly the water vapour which is always evaporating from the surface of our skin, whereby the functions of the body receive a slight check, resulting in a feeling of *malaise*.

Added to these, however, is a far more serious factor which has, up to the present, been overlooked, and that is that an ordinary gas flame, in burning, yields distinct quantities of carbon monoxide and acetylene, the pro-

longed breathing of which in the smallest traces produce headache and general physical discomfort, whilst its effect upon plant life is equally marked.

Ever since the structure of flame has been noted and discussed, it has been accepted as a fact beyond dispute that the outer almost invisible zone which is interposed between the air and the luminous zone of the flame is the area of complete combustion, and that here the unburnt remnants of the flame gases meeting the air freely take up oxygen and are converted into the comparatively harmless products of combustion, carbon dioxide and water vapour, which only need partial removal by any haphazard process of ventilation to keep the air of the room fit to support animal life. I have, however, long doubted this fact, and at length by a delicate process of analysis have been able to confirm my suspicions. The outer zone of a luminous flame is not the zone of complete combustion; it is a zone in which luminosity is destroyed in exactly the same way that it is destroyed in the Bunsen burner; that is, the air penetrating the flame so dilutes and cools down the outer layer of incandescent gas that it is rendered non-luminous, whilst some of the gas sinks below the point at which it is capable of burning, with the result that considerable quantities of the products of incomplete combustion, carbon monoxide and acetylene, escape into the air, and render it actively injurious.

I have proved this by taking a small platinum pipe, with a circular loop on the end, the interior of the loop being pierced with minute holes, and by making a circular flame burn within the loop so that the non-luminous zone of the flame just touched the inside of the loop, and then by aspiration so gentle as not to distort the shape of the flame, withdrawing the gases escaping from the outer zone. On analysing these by a delicate process, which will be described elsewhere, I arrived at the following results:—

GASES ESCAPING FROM THE OUTER ZONE OF FLAME.

	Luminous.	Bunsen.
Nitrogen	76.612	80.242
Water vapour	14.702	13.345
Carbon dioxide	2.201	4.966
Carbon monoxide	1.189	0.006
Oxygen	2.300	1.430
Marsh gas.....	0.072	0.003
Hydrogen	2.888	0.008
Acetylene	0.036	Nil.
	100.000	100.000

The gases leaving the luminous flame show that the diluting action of the nitrogen is so great, that considerable quantities even of the highly inflammable and rapidly burning hydrogen escape combustion, while the products of incomplete combustion are present in sufficient quantity to account perfectly for the deleterious effects of gas burners in ill-ventilated rooms. The analyses also bring out very clearly the fact that although the dilution of coal gas by air in atmospheric burners is sufficient to prevent the decomposition of the heavy hydrocarbons with liberation of carbon, and so destroy luminosity, yet the presence of the extra supply of oxygen does make the combustion far more perfect, so that the products of incomplete combustion are hardly to be found in the escaping gases.

These experiments are of the gravest import, as they show more clearly than has ever been done before, the absolute necessity for special and perfect ventilation where coal gas is employed for the illumination of our dwelling-rooms.

When coal gas was first employed during the early part of this century as an illuminating agent, the low pitch of the old-fashioned rooms, and the excess of impurities in the gas, rendered it imperative that the products of combustion of the sulphur-laden gas should be conducted from the apartment, and for this purpose arrangements of tubes with funnel-shaped openings were suspended over the burners. The noxious gases were thus conveyed either to the flue or open air; but this type of ventilator was unsightly in the extreme, and some few attempts were made to replace it by a more elegant arrangement, as in the ventilating lamp invented by Faraday, and in the adaptation of the same principle by Mr. I. O. N. Rutter, who strove for many years to direct attention to the necessity of removing the products of combustion from the room. But, with the increase of the gas industry, the methods for purifying the coal gas became gradually more and more perfect, whilst the rooms in the modern houses were made more lofty; and the products of combustion being mixed with a larger volume of air, and not containing so many deleterious constituents, became, if not much less noxious, at all events less perceptible to the nose. As soon as this point was reached, the ventilating tubes were discarded, and from that day to this the air of our dwelling-rooms has been contaminated by illuminants, with hardly an effort to alleviate the effect produced

upon health. I say "hardly an effort," for the Messrs. Boyle tried, by their concentric tube ventilators, to meet the difficulty, whilst Mr. De la Garde and Mr. Hammond have each constructed lamps more or less on the principle of the Rutter lamp; but, either from their being somewhat unsightly, or from their diminishing the amount of light given out, none of them have met with any degree of success. In places of public entertainment, where large quantities of coal gas are consumed for illuminating purposes, the absolute necessity for special ventilation gave rise to the "sun burner," with its ventilating shaft. This, however, gives but a very poor illuminating power per cubic foot of gas consumed, due partly to the cooling of the flame by the current of air produced, and partly to its distance from the objects to be illuminated.

The great difficulty which in the whole history of ventilation has opposed itself to the adoption of proper arrangements for removing the products of combustion, has been the necessity of bringing the tube to carry off the gases low down into the room, and of encasing the burner in such a way that none of the products should escape; but with the present revolution in gas burners this necessity is entirely done away with, and the regenerative burner offers the means not only of removing all the products of combustion but also of effecting thorough ventilation of the room itself, as experiments made some few years ago showed me that a ventilating regenerative burner, burning 20 cubic feet of gas per hour and properly fitted, will not only remove all its own products of combustion, but also over 5,000 cubic feet per hour of the vitiated air from the upper part of the room. I am quite aware that many regenerative lamp-makers raise various objections to fitting ventilating lamps, these being chiefly due to the fact that it requires considerable trouble to fit them properly; but I think I have said enough to show the absolute necessity of some such system, and when there is a general demand for ventilating lamps, engineering skill will soon find means to overcome any slight difficulties which exist.

Having disposed in a few words of a subject which, if fully treated, would occupy a long course of lectures by itself, I will pass on to the consideration of gas as at present used as a fuel.

There is no doubt that gas is the most convenient and in many ways one of the best forms of fuel for heating and cooking

purposes, and the efforts which all large gas companies are now making to popularise and increase the use of gas for such purposes will undoubtedly bear fruit in the future. But before the day can come for gas to be used in this way on a large scale, there is one fact which the gas manager and gas stove manufacturer must clearly realise and submit to, and that is that no gas stove or gas water-heater, of any construction, should be sent out or fitted without just as great care being taken to provide for the carrying away of the products of combustion as if an ordinary fuel range was being fitted. Do not for one moment allow yourselves to be persuaded that, because a gas stove or geyser does not send out a mass of black smoke, that the products of combustion can be neglected and with safety allowed to mingle with the atmosphere we are to breathe.

Scarcely a winter passes but one or more deaths are recorded from the products of combustion given off from various forms of water-heaters used in bath-rooms; scarcely a cookery class is given, with gas stoves, that one or more ladies do not have to leave suffering from an intense headache, and often in an almost fainting condition. And the same cause which brings about these extreme cases, on a smaller scale causes such physical discomfort to many delicately organised persons, that a large class exist who absolutely and resolutely decline to have gas as an illuminant or fuel in any of their living rooms; and if the use of gas, more especially as fuel, is to be extended, and if gas is to hold its own in the future against such rivals as the electric light, then those interested in gas and gas stoves must face the problem, and by improving the methods of burning and using gas, do away with the present serious drawbacks which exist to its use.

The feeling has gradually been gaining ground in the public mind that, when atmospheric burners and other devices for burning coal gas are employed for heating purposes, certain deleterious products of incomplete combustion find their way into the air, and that this takes place to a considerable extent is shown by the facts brought forward in a paper read by Mr. William Thomson before the last meeting of the British Association.

Mr. Thomson attempted to separate and determine the quantity of carbon monoxide and hydrocarbons present in the flue gases from various forms of gas stoves and burners, but like every other observer who has attempted

to solve this most difficult problem, he found it so beset with difficulties that he had to abandon it, and contented himself with determining the total amounts of carbon and hydrogen escaping in an unburned condition, experiments which showed that the combustion of gas in stoves for heating purposes is much more incomplete than one had been in the habit of supposing, but his experiments give no clue as to whether the incompletely burnt matter consisted of such deleterious gases as carbon monoxide and acetylene, or comparatively harmless gases, such as marsh gas and hydrogen. After considerable work upon the subject, I have succeeded in doing this by a very delicate process of analysis, and I now wish to lay some of my results before you.

If a cold substance, metal or non-metal, be placed in a flame, whether it be luminous or non-luminous, it will be observed that there is a clear space, in which no combustion is taking place, formed round the cool surface, and that as the body gets heated so this space gets less and less until, when the substance is at the same temperature as the flame itself, there is contact between the two. Moreover, when a luminous flame is employed in this experiment the space still exists between the cool body and the flame, but you also notice that the luminosity is decreased over a still larger area although the flame exists.

This meaning that, in immediate contact with the cold body, the temperature is so reduced that the flame cannot exist, and so is extinguished over a small area; whilst over a still larger space the temperature is so reduced that it is not hot enough to bring about decomposition of the heavy hydrocarbons with liberation of carbon to the same extent as in hotter portions of the flame. Now, inasmuch as when water is heated or boiled in an open vessel, the temperature cannot rise above 100°C. , and as the temperature of an ordinary flame is over $1,000^{\circ}\text{C.}$, it is evident that the burning gas can never be in contact with the bottom of the vessel, or, in other words, the gas is put out before combustion is completed, and the unburnt gas and products of incomplete combustion find their way into the air and render it perfectly unfit for respiration.

The portion of the flame which is supposed to be the hottest, is about half an inch above the tip of the inner zone of the flame, and it is at this point that most vessels containing water to be heated are made to impinge on the flame; and it is this portion of the flame, also, which is utilised for raising various solids

to a temperature at which they will radiate heat.

In order to gain an insight into the amount of contamination which the air undergoes when a geyser or cooking stove is at work, I have determined the composition of the products of combustion, and the unburnt gases escaping when a vessel containing water at the ordinary temperatures is heated up to the boiling point by a gas flame, the vessel being placed, in the first case, half an inch above the inner cone of the flame, and in the second, at the extreme outer tip of the flame.

GASES ESCAPING DURING CHECKED COMBUSTION.

	Bunsen Flame.		Luminous Flame	
	Inner.	Outer.	Inner.	Outer.
Nitrogen	75.75	79.17	77.52	69.41
Water vapour	13.47	14.29	11.80	19.24
Carbon dioxide	2.99	5.13	4.93	8.38
Carbon monoxide....	3.69	Nil.	2.45	2.58
Marsh gas	0.51	0.31	0.95	0.39
Acetylene	0.04	Nil.	0.27	Nil.
Hydrogen	3.55	0.47	2.08	Nil.
	100.00	100.00	100.00	100.00

These figures are of the greatest interest, as they show conclusively that the extreme top of the Bunsen flame is the only portion of the flame which can be used for heating a solid substance without liberating deleterious gases; and this corroborates the previous experiment on the gases in the outer zone of a flame, which showed that the outer zone of a Bunsen flame is the only place where complete combustion is approached.

Moreover, this sets at rest a question which has been over and over again under discussion, and that is whether it is better to use a luminous or a non-luminous flame for heating purposes. Using a luminous flame, it is impossible to prevent a deposit of carbon, which is kept by the flame at a red heat on its outer surface, and the carbon dioxide formed by the complete combustion of the carbon already burnt up in the flame, is reduced by this back to carbon monoxide, so that even in the extreme tip of a luminous flame it is impossible to heat a cool body without giving rise to carbon monoxide, although acetylene being absent, gas stoves, in which small flat-flame burners are used, have not that subtle and penetrating odour

which marks the ordinary atmospheric burner stove, with the combustion checked just at the right spot for the formation of the greatest volume of noxious products.

It is the contact of the body to be heated with the flame before combustion is complete which gives rise to the great mischief; any

cooling of the flame extinguishes a portion of the flame, and the gases present in the flame at the moment of extinction, creep along the cooled surface and escape combustion.

Dr. Blochmann has shown the composition of the gases in various parts of the Bunsen flame to be as follows:—

Height above tube	In tube.	1 inch.	2 inch.	3 inch.	{ Complete combustion.
Air with 100 vols. of gas	253·9	284·7	284·5	484·3	
Hydrogen	48·6	36·4	17·7	16·1	Nil.
Marsh gas	39·0	40·1	28·0	5·7	Nil.
Carbon monoxide	2·9	2·2	19·9	12·7	Nil.
Olefiant gas	4·0	3·4	2·2	Nil.	Nil.
Butylene	3·0	2·5	1·6	Nil.	Nil.
Oxygen	52·7	52·0	21·7	Nil.	Nil.
Nitrogen	199·1	223·8	225·9	382·4	482·3
Carbon dioxide	0·8	3·5	13·0	41·7	62·4
Water vapour	3·1	11·8	45·8	116·1	141·2

which results show that it would be impossible to check the flame anywhere short of the extreme tip (where complete combustion is approximately taking place), without liberating deleterious products.

I think I have said enough to show that no gas stove, geyser, or gas cooking stove should be used without ample and thorough means of ventilation being provided, and no trace of the products of combustion should be allowed to escape into the air; until this is done, the use of improper forms of stove will continue to inflict serious injury on the health of the people using them, and this will gradually result in the abandonment of gas as a fuel, instead of, as should be the case, its coming into general use. The English householder is far too prone to accept what is offered to him, without using his own common sense, and will buy the article which tickles his eye the most and his pocket the least, on the bare assurance of the shopkeeper, who is only anxious to sell; but when he finds that health and comfort are in jeopardy, and has discarded the gas stove, it will take years of labour to convince him that it was the misuse of gas which caused the trouble. Already signs are not wanting that the employers of gas stoves are beginning to fight shy of them, and I earnestly hope that the gas managers of the kingdom will bring pressure to bear upon the stove manufacturers to give proper attention to this all-important question.

So strongly do I feel the importance of this question to the gas world and the public, that

I freely offer to analyse the products of combustion given off by any gas stove or water heater sent to me at Greenwich during the next six months, on one condition, and that is that the results, good, bad, or indifferent, will be published in a paper before this Society, which has always been in the front when matters of great sanitary importance to the public had to be taken up. And if after that the public like to buy forms of apparatus which have not been certified, it is their own fault; but I do think that the maker of any stove or geyser which causes a death should be put upon his trial for manslaughter.

In conclusion, let us consider for a moment what is likely to be the future of gas during the next half century. The labour troubles, bad as they are and have been, will not cease for many a weary year. The victims of imperfect education (more dangerous than none at all, as, whilst destroying natural instinct, it leaves nothing in its place) will still listen and be led by the baneful influence of irresponsible demagogues, who care for naught so long as they can read their own inflammatory utterances in the local press, and gain a temporary notoriety at the expense of the poor fools whose cause they profess to serve. The natural tendency of this will be, that every labour-saving contrivance that can will be pressed into the gas manager's service; and that, although coal (of a poorer class than at present used) will still be employed as a source of gas, the present retort-setting will quickly give way to inclined retorts on the Coze

principle; whilst, instead of the present wasteful method of quenching the red-hot coke, it will be shot direct into the generator of the water gas plant, and the water gas carburetted with the benzene hydrocarbons derived from the smoke of the blast furnace and coke oven, or from the creosote oil of the tar distiller, by the process foreshadowed in the concluding sentences of my last lecture. It will then be mixed with the gas from the retorts, and will supply a far higher illuminant than we at present possess. In parts of the United Kingdom, such as South Wales, where gas coal is dear, and anthracite and bastard coals are cheap, water gas highly carburetted will entirely supplant coal gas, with a saving of fifty per cent. on the prices now existing in those districts. Whilst these changes have been going on, and whilst improved methods of manufacture have been tending to the cheapening of gas, it will have been steadily growing in public favour as a fuel; and if, in years to come the generation of electricity should have been so cheapened as to allow it to successfully compete with gas as an illuminant, the gas works will still be found as busy as of yore, the holder of gas shares as contented as to-day; for with a desire for a purer atmosphere and a white mist instead of a yellow fog, gas will have largely supplanted coal as a fuel, and gas stoves, properly ventilated and free from the reproaches I have hurled at them to-night, will burn a gas far higher in its heating power, far better in its power of bearing illuminating hydrocarbons, and free from poisonous constituents.

When the demand for it arises, hydrogen gas can be made as cheaply as water gas itself, and when time is ripe for a fuel gas for use in the house it is hydrogen and not water gas which will form its basis. With carburetted water gas and 20 per cent. of carbon monoxide we are still below the limit of danger, but a pure water gas with over 40 per cent. of the same insidious element of danger will never be tolerated in our households. Already a patent has been taken by Messrs. Crookes and Ricarde-Seaver for purifying water gas from carbon monoxide, and converting it mainly into hydrogen by passing it at a high temperature through a mixture of lime and soda lime, a process which is chemically perfect, as the most expensive portion of the material used could be recovered; but in the present state of the labour market it is not practical, as for the making of every 100,000 cubic feet of gas, fifteen tons of

material would have to be handled, the cost of labour alone being sufficient to prevent its being adopted; moreover, hydrogen can be made far cheaper directly.

From the earliest days of gas-making, the manufacture of hydrogen by the passage of steam over red-hot iron has been over and over again mooted, and attempted on a large scale, but several factors have combined to render it futile.

In the first place, for every 478·5 cubic feet of hydrogen made under perfect theoretical conditions never likely to be obtained in practice, 56 lbs. of iron were converted into the magnetic oxide, and as there was no ready sale for this article, this alone would prevent its being used as a cheap source of hydrogen; the next point was that when steam was passed over the red-hot iron, the temperature was so rapidly lowered, that the generation of gas could only go on for a very short period, whilst, finally, the swelling of the mass in the retort, and fusion of some of the magnetic oxide into the side renders the removal of the spent material almost an impossibility. These difficulties can, however, be got over. Take a fire-clay retort, six feet long and a foot in diameter, and cap it with a casting bearing two outlet tubes closed by screw valves, whilst a similar tube leads from the bottom of the retort. Enclose this retort by a furnace chamber of iron lined with fire brick, leaving a space of two feet six inches round the retort, and connect the top of the furnace chamber with one opening at the top of the upright retort, whilst air blasts lead into the bottom of the furnace chamber, below rocking fire-bars, which start at the bottom of the retort, and slope upward, to leave room for ash holes closed by gas-tight covers. The retort is filled with iron or steel borings, alone if pure hydrogen is required, or cast into balls with pitch if a little carbon monoxide is not a drawback, as in foundry work. The furnace chamber is now filled with coke, fed in through manholes, or hoppers, in the top, and the fuel being ignited, the blast is turned on, and the mixture of nitrogen and carbon monoxide passes over the iron, heating it to a red heat, whilst the fuel in contact with the retort does the same thing. When the fuel and retort full of iron are at a cherry-red heat, the air blast is cut off, and the pipe connecting the furnace and retort, together with the pipe in connection with the bottom of the retort, are closed, and steam, superheated by passing through a pipe led

round the retort or interior wall of the furnace, is injected at the bottom of the red-hot mass of iron, which decomposes it, forming magnetic oxide of iron and hydrogen, which escapes by the second tube at the top of the retort, and is led away either to a carburetting chamber if required for illumination, or direct to the gasholder if wanted as a fuel. The mass of incandescent fuel in the furnace-chamber, surrounding the retort, keeping up the temperature of retort and iron sufficiently long to enable the decomposition to be completed.

The hydrogen and steam-valves are now closed and the air blast turned on. The hot carbon monoxide passing over the hot magnetic oxide, quickly reduces it down to metallic iron, which, being in a spongy condition, acts more freely on the steam during later makes than it did at first, and being infusible at the temperature employed, may be used for a practically unlimited period.

What more simple method than this could be desired. Here we have the formation of the most valuable of all fuel gases at the cost of the coke and steam used, a gas also which has double the carrying power for hydrocarbon vapours possessed by coal gas, whilst its combustion gives rise to nothing but water vapour.

In this course of lectures I have left much unsaid and undone which I should have liked to have had time to accomplish, and if I have been obliged to leave out of consideration many important points, it is the time at my disposal and not my will which is to blame. And now, in conclusion, I wish to express my thanks to my assistants, Messrs. J. A. Foster and J. B. Warden, who have heartily co-operated with me in much of the work embodied in these lectures.

SEVENTH ORDINARY MEETING.

Wednesday, January 21st, 1891: Captain W. DE W. ABNEY, C.B., F.R.S., in the Chair.

The following candidates were proposed for election as members of the Society:—

Broadbent, Harry, 31, Victoria-terrace, Belle Vue-road, Leeds.

Craggs, John George, Stone-house, St. John's, S.E. Darnley, Earl of, Cobham-hall, Gravesend.

Holtzapffel, John J., 64, Charing-cross, S.W.

Rawcliffe, Henry, J.P., Pool Bank, New Ferry, Birkenhead.

Rhodes, George Webber, 131, Wool-exchange, E.C. Weld-Blundell, Herbert, 104B, Mount-street, W.

The following candidates were balloted for, and duly elected members of the Society:—

Blades, Rowland Hill, 23, Abchurch-lane, E.C.

Blissett, T., 5, Grenville-ter., Cromwell-rd., S.W.

Erhardt, William, 7, Bury-street, Bloomsbury, W.C.

Fearon, Henry S., 5 & 6, Great Winchester-st., E.C.

Firth, John W., Manningham, Bradford, Yorks.

Jones, Edward, 5, Moorgate-street, E.C.

Lane, Frederic, 3, Crown-court, Old Broad-street, E.C.

Sutton, George, 27, Martin's-lane, Cannon-street, E.C.

Thorne, Edward Alexander, 1, Blenheim-road, Bedford-park, Chiswick.

Watts, John Isaac, 4, Halkin-street West, Belgrave-square, S.W., and Whistley-house, near Devizes, Wilts.

The paper read was—

PHOTOGRAPHY IN ANILINE COLOURS.

BY A. G. GREEN, C. F. CROSS, AND
E. J. BEVAN.

It does not require any very refined faculties of observation for the appreciation of the stupendous work continually brought upon the face of the earth by the sun's light and heat. In very early ages this appreciation has been signalled by the deification and worship of this great centre of force: and if in these latter days of scientific investigation and exact knowledge we do not allow our feelings to carry us away in contemplating the great luminary itself, or the brilliant and mighty workings of its ceaseless energy, it is only because the struggle for the life which it inspires and sustains is too severe for more than occasional contemplation of the poetic side of the natural order. In the modern art of photography we have much that appeals to our most refined perceptions, both æsthetic and scientific, and the new photographic process which we have undertaken to bring to the notice of the Society affords an occasion, apart from its more direct application to æsthetic and utilitarian ends, not merely of extending our grasp of the *results* of modern science, but, what is more important, of the phenomena upon which they are based. Our ordinary inquiries as to these results are too often limited to extrinsic considerations: we find them useful or beautiful, or both, and that is sufficient. The scientific spirit, on the other hand, leads us beyond the region of sensuous impressions into that of the ultimate components of matter and of force: an unseen

world, but far more real to the scientific imagination than the visible arena of gross or aggregate results. If we are to understand how it is that light can so affect matter as to be able to impress itself by bringing about a permanent change in its composition—which is the essential idea of photography—we must know what are the ultimate reacting elements, dynamic and material. The factors of the problem are the *light*, or agent; the sensitive substance or matter acted upon; and the third, the inevitable *tertium quid*, or *medium* through which entities so totally distinct as force and matter are brought into reactive relationship.

We will begin with a few elementary considerations as to the nature of light.

To ordinary visual observation, a beam of sunlight is homogeneous luminosity. Most of us, on the other hand, are doubtless aware that science gives a very different account of solar radiation from what might be reasoned from mere sense impressions, showing it to be a highly complex aggregate of force—elements differing widely, not only in their dimensions but in the phenomena to which they give rise. We may prepare the way for a short description of the results of analysing solar radiation, and observing its ultimate components in detail, by an illustration taken from more familiar sources. When we speak of the English army, we may think of it as the collective expression of the physical force of the English people; but when we think of the army in action, we picture infantry, cavalry, and artillery; and, further, each of these arms as made up of the actual fighting units or individual soldiers. So with solar radiation. We find it active in three distinct directions, giving rise to the effects of heat and chemical action, in addition to those of light; and that these aggregate effects—observable in the aggregate by the senses—are caused immediately by the unit constituents or force-elements, of which we come now to speak more particularly. If we cause a convenient section of sunlight to pass through a prism of glass or crystal, we bend the light out of its course, and, as an additional result, it is decomposed into a band of coloured light—the solar spectrum. In other words, the several constituents of solar radiation—thus spread out or separated—are affected by the prism in the order of their dimensions; and, in corresponding order, they affect the organ of vision, giving rise to the succession of colour effects with which we are familiar in the rainbow.

That these coloured lights are the actual constituents of white light is easily proved, by causing them to pass through a second prism, conveniently disposed, so that the bending or dispersion may be reversed. From this second prism a beam of pure white light emerges.

On further examining the spectrum, we find that not only do the light effects vary from point to point, but that effects of heat and chemical action, which are caused by the constituents of solar radiation, also vary considerably. The heat rays we may regard as localised at the red end of the spectrum, extending considerably beyond the visible limit. The chemical activity of the spectrum, on the other hand, we cannot regard as localised, excepting for particular effects. Thus, for the more familiar processes of photography, the chemical effects upon which they depend are chiefly produced by rays situated towards the violet end; whereas in the photographic process which forms the subject of this communication a much wider range of activity is discernible, extending from the violet through the green, well into the orange portion of the spectrum. We shall revert to this, the more important part of our subject, after saying a few words as to the actual nature of the solar radiation, which manifests itself to us in this three-sided activity.

The older view, that it was a kind of matter emitted by the sun and transmitted to us through space, is no longer held; this cruder view has given place to the undulatory theory of the nature of radiant energy, according to which it is an undulatory disturbance or a wave motion in what is called the universal ether. With regard to this ether, we need only observe that the propagation of a motion through space postulates a transmitting agency or medium, and the enormous velocity of its propagation—186,000 miles per second—postulates a medium of very high elasticity. And this ether must evidently pervade all substances; how otherwise could we have the property of transparency or light transmission?

With regard to wave motion, we can only put forward one or two elementary considerations to enable those who have not considered the subject to form some mental picture of the effect. If we twist a corkscrew we notice the propagation of a wave in the direction of the axis; this wave evidently is one of *form* only, as there can be no translation of the substance of the screw. The effect of wind upon a piece of standing corn is to create a succession of waves, which, again, are waves of form caused

by the oscillation of the individual stalks to and fro in regular succession. Lastly, the waves of the sea are not caused by a forward movement of the body of water; it is an appearance of movement of this kind, but, actually, the disturbance of the water, *i.e.*, of the water particles, is in the vertical plane, that is, up and down. We will illustrate waves of this kind by means of a mechanical diagram, and conclude our brief description with the lucid definition of wave motion by a well-known author, as a continued transmission of a relative state of particles, their motion separately considered being, on the other hand, a reciprocating motion. Such we will take to be the nature of the waves of radiant energy. The lengths of these waves vary from point to point of the solar spectrum from $\cdot 0000193$ inch in the red, to $\cdot 0000099$ inch in the violet. Remembering that the velocity of propagation of the disturbance is 186,000 miles per second, we may reckon the number of wave impacts per second upon an illuminated surface, arriving at numbers which surpass our mental grasp. We have now to inquire how the bombardment of these infinitely tiny waves can effect chemical decomposition, can undo the combination of matter with matter, producing in certain substances those changes which give, either directly (when a colour change is directly produced) or by development (where coloured compounds can be built up upon the surface affected by the light), photographic pictures.

If we bring together such a metal as silver—a simple or elementary substance—and the elementary gas chlorine, combination instantly ensues, attended by considerable evolution of heat. The product is a white compound devoid of metallic lustre, and altogether different in external properties from either of the elements which have combined to produce it. Now, how can we decompose this product, chloride of silver, and restore the silver and chlorine to the free state? By putting back into the compound the energy or force which was set free and lost in the act of combination. This we can do in two ways. By means of the electric current, or by the action of light.

The former admits of easy demonstration. Thus, on taking a suitable solution of the chloride, and inserting two copper plates connected with the terminals of a galvanic battery, there is an instant deposition of silver on the one, and the chlorine goes to the other plate. Now, the well known darkening of

silver chloride on exposure to light is actually not so simple a resolution as that which we have demonstrated, but, essentially, it is the same: the darkened product is richer in silver than the original; and chlorine may be easily demonstrated to be set free in the process.

And this is a typical case of the action of light. It is an addition of energy to a compound, and an undoing thereby of the act of combination by which it was produced. Witness the stupendous work accomplished by light in building up the vegetable world around us. The raw material which is employed by nature is the carbonic acid of the air—a compound of carbon and oxygen. This it decomposes in the plant cell, restoring the oxygen, and building up the carbonaceous residue into the structure of the plant. To understand how the infinitely tiny waves of light which have no weight can tear asunder masses of substance, such as silver and chlorine, requires an exercise of imagination. There is an enormous weight of evidence to prove that all matter is made up of infinitely small masses, all equal, and equally endowed with the properties which mark the substance. These are the atoms of the chemist. These are in active motion. Chemical combination is a coming together of atoms. The heat and light evolved in combination is the result of the atomic collisions; and in consequence of the collision there is a loss of motion. It is these atoms—which are freely accessible to the all-pervading ether—which respond to the impulses of the waves of radiant energy; and it is in this invisible region, remote from sense impressions, that the phenomena which we are about to consider take place.

We shall confine ourselves to processes based upon the aniline or coal-tar colours, since we find them completely typical of photographic processes generally.

The simplest method of producing a picture in any of these colours is based upon the familiar observation that these colours—dyed upon fabrics—all fade more or less on exposure to sunlight. This destruction is a complicated action, and therefore we shall not attempt to examine it in detail. We shall content ourselves with exhibiting prints obtained by exposing to sunlight, paper coated with two dyestuffs, which we select as specially fugitive, *viz.*, eosine and methylene blue, under glass positives, as in any of the ordinary and familiar printing methods.

In these prints the gradations of shade are

exactly reproduced; those portions which received most light are the most bleached, whereas the shadows of the object have protected the portions of paper beneath them, and by the preservation of the colour the depth of shadow of the original is reproduced. We need scarcely point out that such a method of photography has no practical value; not only is a prolonged exposure necessary, but the prints, in addition to being somewhat unsatisfactory in themselves, have this disadvantage—that, under the ordinary conditions of exposure, the colour will continue to fade over the whole surface, with the gradual obliteration of the picture.

What we want to make such a process practically available is a compound possessing (1) a high degree of sensitiveness, and (2) the property of entering into combination with some other compounds giving a product which will resist the further action of the light.

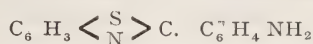
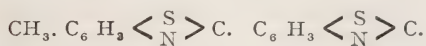
In the diazotype process, which is the main subject of this paper, we have as the actual photographic agent not only a highly-sensitive compound—highly sensitive, that is, to the action of light—but one which can be readily converted into a variety of colouring matters. The process consists of four stages:—(1) Dyeing or coating the surface upon which it is required to photograph with a particular compound, which is then (2) converted into a photo-sensitive derivative, and (3) exposed to the light under the usual conditions for giving the picture; (4) converting the sensitive compound wherever it survives, through having been protected by the shadows of the object photographed, into colouring matters; thus the picture is developed from the weakly-coloured sensitive compound into well-marked shades of red, orange, brown, purple, or blue; and these shades being formed in stable colouring matters, the picture is at the same time fixed.

For the better understanding of the process it is necessary that we should acquaint ourselves with the properties of these substances apart from any reference to photographic action.

The compound we start with is a yellow-coloured body,* to which the "trivial" name of primuline has been given. This compound is obtained by the action of sulphur upon toluidine, a coal-tar base closely allied to aniline. In this action not only is there com-

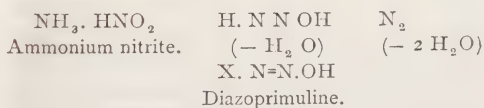
bination with sulphur, but several molecules of the toluidine are built up into one complex molecule.

Thus to express the matter in our modern formulæ, we start with $C_6H_3 \cdot CH_3 \cdot NH_2$ toluidine, and obtain—



primuline base. A very formidable-looking compound. Now the important part of this formula to us is not the unwieldy body, but the head, the small group NH_2 . We can consider primuline in its simplified form $X \cdot NH_2$, and we see that this differs from ammonia, $H \cdot NH_2$, in having one H replaced by a complex group. Corresponding to this general resemblance, there is a similarity in their distinguishing property; both are basic or alkaline substances, and combine with all acids to form salts. One only of these we have to consider, that by combination with which the stable primuline—highly resistant to all agencies which destroy the more fugitive colouring matters—is converted into a photo-sensitive derivative. This acid is nitrous acid HNO_2 . Nitrous acid and ammonia combine to form ammonium nitrite. When this nitrite is heated, it is resolved spontaneously into nitrogen gas—the inert constituent of atmospheric air—and water.

Now primuline, in common with all coal-tar bases, combines with nitrous acid to form a species of nitrite, which is termed a diazo compound. All that we need note about these diazo compounds is that they correspond to the intermediate stage in the transition of the ammonium nitrite to the condition of nitrogen (and water) thus:—



These diazo-derivatives are, as a class, sensitive to light, undergoing decomposition with evolution of nitrogen gas. But what concerns us for the moment is their avidity for constructive or synthetic reaction with two large groups of coal tar compounds—the amines and phenols. With these they combine very much as the original bases combine with nitrous acid to form these active diazo compounds, and the products are the azo-colouring matters. We cite the more important of these, obtained from primuline. In the case of the

* Discovered by A. G. Green in 1837. See "J. Soc. Chem. Ind.," 1888, 179.

several phenols, their alkaline solutions are employed; while in the case of the bases acid solutions are used—

These relations we demonstrate with diazo-primuline and the several reagents above mentioned.

Primuline and Nitrous Acid gives *Diazo-primuline*, and *Diazo-primuline* with—

β Naphthol. <i>Red.</i>	Phenol. <i>Yellow.</i>	Resorcin. <i>Orange.</i>	Pyrogallol. <i>Brown.</i>	α Naphthylamine. Hydroc <i>Purple.</i>	Amido. β Naphthol. Sulphuric Acid. <i>Blue.</i>
----------------------------------	---------------------------	-----------------------------	------------------------------	---	---

We now come to the photographic application of these reactions. The essential condition of primuline photography is—(1) that these reactions take place with primuline after its application to any surface or material, such as wool, silk, &c., as a dye, without in the least affecting its union with the material; and (2) that the diazo-derivative produced, in combination with these materials, by treating the primuline-dyed surface with nitrous acid, is photo-sensitive in the highest degree, far more so, in fact, than the derivative itself, when free or uncombined.

Having thus prepared the way, we proceed to a complete experimental demonstration of the process. We first show the building up of the colouring matters upon the cotton and silk fabrics, showing that the reactions take place in silk without disturbing the union between the colouring matter and fabric; and that the azo-colouring matters so built up withstand the action of boiling soap.

We have now to demonstrate the sensitiveness to light of a surface dyed with primuline, and sensitised by treatment with nitrous acid, and we shall show that the action of the light is to destroy the diazo-derivative that this destruction is due to the splitting off of its two characteristic nitrogen atoms in the gaseous form. We are enabled to show this to an audience owing to the curious fact that, in a gelatine medium the nitrogen, though liberated from combination, is not evolved until the gelatine is softened by contact with water. We expose a primuline-gelatine plate to photographic action, and on plunging into a transparent bath of water an image of which is thrown on the screen, we see the form of the print instantly developed in minute bubbles of gas. On then treating the plate with one of our developers, we see that when the gas has formed—the evidence, *i.e.* of the destruction of the diazo-primuline—there no development of colour takes place.

We now develop a number of prints which have been exposed in the daylight, and brought

here in the condition in which they left the printing frame. In these developed pictures the high lights are represented by the neutral tint—varying from buff to cream—of the product of destruction of the diazo derivative, the absence of development in these portions being due to the chemical inertness of this product.

The development of colours corresponding to the shadows and half tones of the object is exactly proportionate to their depth, to the degree of protective action which they have exerted on the sensitive surface beneath—in other words, to the quantity of diazo-primuline which survives.

Reverting to the considerations which we advanced in the earlier portion of this paper, we should explain the action of the light as an addition of energy or atomic motion to the molecule of the diazo-primuline, whereby the split or cleavage of the molecule at the point occupied by the two nitrogen atoms is determined, just as by adding heat to ammonium nitrite its molecule is resolved into nitrogen, and a residue, which in this case is not a complex compound, but water.

We have already alluded to the fact that the rays which attack the diazo-primuline are by no means confined to the blue and violet constituents of the spectrum, but extend well through the yellow to the orange red. In other words, a primuline print is more nearly a measure of the visual intensity of the sun's rays than the sensitive substances used in the ordinary methods of photography, in relation to which it is well known that the photographic intensity of sunlight is a very different thing from visual intensity, owing to the enormously greater activity of the blue and violet rays—*i.e.*, those of least visual intensity—in decomposing the compounds which they employ.

It will be convenient here to point out another contrast of this method with those more commonly employed. The prints obtained with it are positives, the light and shadow in the object being exactly produced in the coloured

picture. Natural objects, therefore, of convenient form, such as leaves, may be photographed directly; reproductions from camera pictures require glass positives, or positive paper prints made transparent in the usual way with vaseline.

In view, perhaps, of the chemistry of the method, it would perhaps be more correctly termed a negative method, since the action of the light is destructive, and where it acts, the construction or development of the colour is rendered impossible. In the ordinary methods, on the other hand, the light is an agent, as it were, in the synthesis of colour—where there is most action the deepest tones are developed—and the photographic action would in this case perhaps be more correctly termed positive. The point, however, is not a very important one.

There now remains to be noticed a second photographic process based upon the peculiar properties of the diazo-derivatives of the coal-tar bases; a method which, to use the ordinary term, is a negative one, *i.e.*, the light plays a constructive part in the development of a coloured picture.

When the diazo compounds are treated with an alkaline bisulphite, they are converted into the diazo sulphonates. These compounds are sensitive to light, the action of which is to set free the diazo group from its combination, but they do not react with phenols and amines, as do the diazo compounds. The mixture of a diazo sulphonate with the latter is unattended by any colour reaction, but, on exposure to light, the diazo group being set free in presence of a phenol, the development of an azo-colour takes place *pari passu*. This reaction is the basis of the process invented and patented by A. Feer. The photographic surface is a mixture of a diazo sulphonate with the alkali compound of a phenol applied to any suitable material. On exposure to light under a transparency, development of colour takes place in proportion to the quantity of light transmitted, giving, therefore, a reversed reproduction, or negative picture. When printed, the unattacked mixture is dissolved away by copious washing, leaving the picture, already developed in the azo-colour, which is relatively insoluble, permanently fixed upon the fabric or material.

This process is not rapid enough to admit of being conveniently demonstrated by means of the artificial light at our disposal. We must therefore content ourselves with this brief description, referring those who wish for fur-

ther information to the specification of the original German patent, No. 53,455/ga.

In concluding our brief sketch of this new departure in the application of the coal tar colours, we need not, perhaps, apologise for its brevity. We learn that our friend, Professor Meldola, is to give a course of Cantor Lectures on "Photographic Methods;" and his survey of the field will be wide and complete. We have not attempted to give a general account of photographic methods partly on this account, and partly, also, because these diazotype processes are entirely typical of all printing processes, and, as subjects of lecture or educational demonstration, have the great advantage of involving the very simplest reaction possible; whereas, the changes which take place in silver compounds are very complicated, and as yet but imperfectly understood.

The primuline process is simplicity itself. It can be practised with the minimum of apparatus, and requires no technical training. The results are striking and pleasing, as we hope to have been able to show.

We cannot conclude without a cordial expression of our indebtedness to the Chairman, Captain Abney, for very valuable assistance in investigating the physical elements of the subject. The results we have only been able to glance at in a lecture of this scope; they will be dealt with in full at another time and place.

To the Autotype Company, through their Manager, Mr. W. S. Bird, we would also express our thanks, for the loan of positives, and for other kind assistance.

DISCUSSION.

Mr. DALLMEYER asked if these colours had been examined with regard to their spectral properties, especially when combined with gelatine. Great endeavours had been made to obtain glasses which were especially sensitive to certain portions of the spectrum, and it would be interesting to know if any of these colours had this quality.

Mr. WARNERKE asked if the yellow colour of the background could be got rid of?

Mr. W. T. LYE inquired how the process could be applied to photography in general? He did not see how it was to be applied, except to cotton or woollen fabrics.

Mr. WUENSCH said he understood that this dye had

been used extensively in Manchester, but was it simply as a dye, or for purposes of ornamentation?

Mr. CROSS, in reply, said he would leave the Chairman, who had paid special attention to that branch of the subject, to answer Mr. Dallmeyer's question. The yellow could not be entirely avoided with primuline, it was as essential to the product of decomposition by light as primrose yellow to the original primuline; but this was only the beginning of an entirely new development, and they had already succeeded in getting prints with other bodies of this class, which gave a very satisfactory approximation of the colourless ground which was such a desideratum for a large class of work. He did not quite understand the question how it was to be applied. They had printed from ordinary photographic positives; prints might also be taken from natural objects, such as ferns, leaves, &c., or an over-printed bromide print might be made transparent with vaseline, and it would yield a very satisfactory print. The applications were absolutely general, so far as photographic printing was concerned. It was for the future to decide what applications of it might be made by amateurs, ladies and others. The process was exceedingly simple; it required absolutely no technical training, and the minimum of apparatus. The fabrics would stand washing in boiling soap solution; and it seemed to him that here was an immense field open for the beautifying of dwellings, which it was for the public to make use of. Some of the prints exhibited were from glass positives lent by the Autotype Company; and a pretty wide range of objects had been selected. Primuline, as a dye, was invented two years ago, and had been used, to a large extent, by dyers; but its photographic application was a novelty. In conclusion, he had only to say that any one who was interested in the matter might obtain more detailed particulars by calling at his laboratory.

The CHAIRMAN said he thought Mr. Bevan could give most information about the absorption spectrum, though he himself had taken the observations, being familiar with the apparatus, and the only one who could read it. As a matter of fact, the absorption spectrum corresponded very closely with the printing action of the light, the lowest point of the curve being between the orange and the red. He had worked a little with this process, and had been very much fascinated with it, and would recommend everyone to introduce it to the ladies of their households as a perpetual source of amusement, and a means of decoration. They knew how fond ladies were of occupying their leisure time in quasi-artistic pursuits of this character, and here was a method by which they could give a high decorative quality to their cushions and other articles by printing natural subjects upon them. They would be able to group ferns and leaves together into much more artistic combinations than the specimens which

had been shown that evening, he had no doubt. The operation could be carried on, not, perhaps, in the drawing-room, but in the parlour; the apparatus being very simple, and the materials harmless. They were much indebted to these gentlemen for bringing forward this subject. It was not every day that a new photographic process was brought forward, but this was absolutely new, and, as a photographer, he hailed anything which added to their knowledge of the means of producing pictures of any description. Unfortunately, it was not quite sensitive enough at present for the camera, but they could not say how far it might be developed. They had long been talking about photographing in colours, and something had been done in that way with carbon. This was not photographing in natural colours, but it gave the means of producing prints in a great variety of tints, and without that nicety of manipulation which the carbon process required. He concluded by moving a hearty vote of thanks to the authors of this paper.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

KATH OR PALE CATECHU.

A memorandum by Dr. H. Warth, on the preparation of Kath or Pale Catechu, has been received from the Secretary of State for India, from which the following particulars are taken:—

“The kath of the North-West Provinces, which is used with pán, and the catechu of Burma, which is exported to Europe as a dye-stuff, are both prepared from the wood of *Acacia catechu*. The kath is in its purest state chiefly catechin, a crystallizing substance, nearly insoluble in cold water. The catechu is chiefly catechu tannin, a substance soluble in cold water and not crystallizing, but some catechin is usually mixed up with it. The difference between kath and catechu is partly due to the methods of manufacture, partly to the difference in the trees.

“The trees in Burma differ from those of the North-West Provinces, and at each place there are two kinds of trees, Nos. 1 and 2, although of exactly the same species. Trees No. 2 have white spots in the wood, caused by a white substance stored up in cylindrical masses half a millimetre thick and ten millimetres long. Trees No. 1 have no white spots. Trees with spots yield an extract richer in catechin; and both kinds of trees in the North-West Provinces yield more catechin than the corresponding kinds in Burma.

"I found the following proportions of catechin in the total extract :—

	Catechin.
Burma, No. 1	14 per cent.
„ No. 2 (spotted)	30 „
North-West Provinces, No. 1	36 „
„ „ No. 2 (spotted).	40 „

"The greatest amount of extract obtained from each kind of wood was as follows :—

	Extract.
Burma, No. 1	17 per cent.
„ No. 2 (spotted)	18 „
North-West Provinces, No. 1	14 „
„ „ No. 2 (spotted).	24 „

"The greatest amount of catechin obtainable from these woods is, accordingly, as follows :—

	Catechin.
Burma, No. 1	2 per cent.
„ No. 2 (spotted)	5 „
North-West Provinces, No. 1	5 „
„ „ No. 2 (spotted)	9 „

"Such a great proportion of catechin in the spotted wood of the North-West Provinces explains that Kath manufacture is at home there. Moreover, the local kath makers are reported to refuse as unfit all trees which do not contain white spots, so that the trees No. 1 become wasted in the forests.

"I determined the catechin by direct separation, as follows :—About two ounces of the wood reduced to thin shavings were boiled with twenty times their weight of water for half an hour. The extract was separated from the wood by repeated settlement, and reduced in bulk on the water bath until it just began to thicken, and contained, by estimate, 6 per cent. of catechin. It was then left in a cool place for five days for the separation of the catechin. Once the catechin had separated, the liquid could again be diluted with cold water for the purpose of filtering. The filtered and roughly-washed catechin was dried at ordinary temperature, and weighed in a thoroughly air-dry condition.

"The high degree of concentration and the long standing are required because the catechin separates with difficulty out of an extract which contains so much catechu tannin. Once the bulk of the tannin is separated, the catechin may be dissolved in much more water, and it will separate immediately on cooling, but the catechin is at all times a delicate substance, which changes with water slowly into a soluble substance, and is thus lost. The drying of the moist catechin must take place at a low temperature, as heat at once destroys the microscopic crystals.

"The manufacture of kath, or raw catechin, is carried on in the forests with very primitive appliances. The filtering is done through layers of sand, and much sand becomes mixed up with the kath. The drying is performed in the open air.

"Contact with iron must be scrupulously avoided,

during the extraction of catechin. With catechu or cutch, contact with iron is of no consequence; and the reports mention iron cauldrons in use for the final boiling down of the cutch in Burma."

THE TULLE INDUSTRY IN FRANCE.

The date of the first manufacture of tulle in France is relatively recent. It was unknown at the beginning of this century. Consul Williams, the United States Consul at Calais, in his report upon the lace-makers' strike in that town, says that tulle, in fact, is only lace manufactured by machinery. Lace manufacture has always been a French industry. Chantilly, Alençon, Velay, and Flanders have retained a celebrity for this branch of art, which has survived the destruction of their workshops. To Nottingham is accredited the establishment of the first machinery for the manufacture of lace. The inventor was William Lee, who was protected by Queen Elizabeth for a time; but, being afterwards neglected, he went to France. On the death of Henri IV. he was forgotten, and he died in Paris in 1610. The English workmen whom he brought with him returned to their country, and established the industry which the French had disdained. Lee's machines were improved, even in France, where, meanwhile, notwithstanding the encouragement of the Academy of Science, the inventors could not introduce their designs. In 1779, John Lindley, of Nottingham, discovered the bobbin, by means of which he could imitate the network of lace. In 1809, a workman named Heathcote discovered the hexagon mesh, which is the foundation of tulle. He joined Lindley, and manufactured tulle on a large scale. Other inventions rapidly followed. France, meanwhile, stood aloof, and tulle remained an English monopoly. In 1815 or 1817, a machine was brought into France; some say at Donai, and others at Calais. However this may be, a man named Webster was known as the pioneer of tulle manufacture at Calais, where he established his works at St. Pierre, on the bank of the canal. After a brief interruption he resumed business in 1819 with Bonnington, the father of the painter. In the same year five English workmen from Nottingham brought their machinery piece by piece, and established themselves at Calais. These men, it is stated, were condemned to death for contumacy in having fraudulently taken out of the country a machine for the manufacture of lace, and were only pardoned after the accession of George IV. The industry was hampered on account of the difficulty and expense of procuring machines; these could only be brought in by pieces. The smugglers ran the blockade, and landed at Boulogne or at Calais. The smuggler assisted the trade also by bringing in the thread manufactured in England for the use of the lace manufacturer, the French spinners having succeeded in prohibiting the entry of thread. In spite of this continual struggle,

the number of factories increased. St. Pierre had four, Guines had a bleaching establishment, and Calais had eight factories. This city seemed destined to become a lace centre, but the presence of the workmen and the din of the machinery were so repugnant to the quiet citizens that, at their instigation, the mayor took such steps to restrain their movements and control their hours of work, that they gradually moved towards St. Pierre, which was not within his jurisdiction. These works were dependent upon foreign workshops for their machinery till 1823, when two mechanics established a factory for the construction of lace machines. From 1824 to 1826 tulle was in great demand, and France and England realised enormous profits from this trade. The increase in the establishment of factories was very great. St. Pierre alone had twenty-three factories and eight workshops for the construction of machines. In 1832, a violent crisis occurred, owing chiefly to the excessive duty imposed upon English thread. The number of factories by this time had increased to 323, of which 136 were at Calais, 109 at St. Pierre, and 78 in the suburbs. Each factory had but two looms, and the work was plain. It was not long before an entire change was effected, and Calais became what it is to-day, by the application of the Jacquard loom to the manufacture of tulle. This innovation took place in 1841. The crisis of 1834 had so reduced the number of factories, that the number of manufacturers, from 1834 to 1837, fell from 302 to 249, and the workmen from nearly 3,000 to 1,500. Many emigrated with their looms to Russia, Belgium, Lyons, and St. Quentin. The application of the Jacquard system to the loom for tulle, made by Fergusson and Martin, arrested the decline of this trade. Steam had already come to the rescue, the first engine being applied to their use in 1839 at St. Pierre. Furnished with steam power, and a loom admitting the execution of the most delicate designs, St. Pierre continued to prosper. The report at the time of the London Exhibition, in 1851, stated that St. Pierre had 130 factories, and 500 looms, worth 10,000,000 francs (£400,000). At the Paris Exhibition of 1855, the number of looms had increased to 610 against 3,500 at Nottingham; that of the workmen to 5,000, and the value of the product to 15,000,000 francs (£600,000). Treaties of commerce gave another impetus to this trade by permitting the entry of thread at a lower rate, and new markets opened up. In 1862, the superiority of the French manufacture over that of England was recognised by the fact that Great Britain bought, in that year, 26,000 kilogrammes, having increased the amount from 3,600 kilogrammes in 1860. In 1870, the number of looms was 939, valued at 15,000,000 francs. After the war, the impetus was still greater, and at the time of the Exhibition of 1878, St. Pierre had 1,500 looms, moved by eighty engines and owned by eighty manufacturers. The value of the plant was 40,000,000

francs (£1,600,000), the annual output 60,000,000 francs (£2,400,000), and the number of workmen employed amounted to 10,000. The prosperity of St. Pierre seemed assured, when a new crisis arose in 1885. It was expected that the lace called Chantilly would rule the market, and large quantities had been manufactured and stored, in 1884, with a view of anticipating the supposed demand. A sudden and unaccountable change of fashion gave preference to a woollen lace manufactured at Velaz, Auvergne, and Forez. There were large surplus stocks, consequently, held in nearly all the houses, and the loss was immense. The tulle industry requires large advances for the purchase of raw materials. Many houses ask, at certain seasons, advances from a 100,000 to 150,000 francs from the local banks.

THE INDUSTRIAL CONDITION OF CHILI.

A Chilian correspondent of the *Economiste Français* says that the various industries in that country are in a very satisfactory condition, and efforts are continually being made to increase their number and their prosperity. At Santiago and Tomé there are many establishments for the manufacture of cloth, and these turn out articles of very superior quality. There are also establishments for the production of beer, sugar, earthenware and pottery, candles, paper, and bottles, as well as sugar refineries and saw mills. The milling industry is an important one, in fact it is one of the principal industries of the country, and it is estimated that there are at least 750 mills. A curious industry, and one peculiar to the country, is the manufacture of palm honey. In one warehouse in Las Palmas de Ocoa, there are stored 200,000 tin boxes containing 200,000 lbs. of honey. Since the beginning of 1890, the Chilian Government has ceased to levy customs duties upon the importation of machinery and materials for the construction of railways and telegraphs. Agriculture is in a prosperous condition; the production of wheat averages 10,000,000 hectolitres (the hectolitre is equivalent to 2.75 bushels), and other cereals represent a production of 3,000,000 hectolitres. Fruits and vegetables are abundant. About 500,000 head of cattle are annually raised, and 2,000,000 of sheep, goats, &c. Last year's wine harvest was a good one, and it is stated that about 300,000 quarts of wine and other liquids are annually exported. Chilian wine is beginning to be appreciated abroad, and has obtained several medals and honourable mention at many exhibitions. There are many important copper, silver, and gold mines in the country. From 1844 to 1888, Chili exported fine copper to the amount of 1,402,000,000 kilogrammes (kilogramme = 2.204 lbs. avoirdupois), valued at 467,500,000 piastres, and fine silver to the amount of 3,504,000,000 grammes, representing a value of more than 148,000,000 piastres. The exports of gold ore amounted to 3,800,000

grammes, valued at 1,215,000 piastres in 1888, and 1,500,000 piastres in 1889. In 1889, manganese ore was exported to the value of 265,000 piastres. Coal exports in the same year amounted to 146,000 tons, representing a value of 1,315,000 piastres. The State railways have a total length of 1,096 kilometres (kilometre = .621 of a mile), and the lines belonging to various companies have a total length of 1,641 kilometres, exclusive of those in connection with the Coronel, Lebu, and Lota collieries. Tramways have been established at Santiago, Valparaíso, Concepción, Copiaco, Chillan, Limache, Rengo, Quillota, San Felipe, Santa-Rosa, Serena, Talca, &c. The postal, telegraphic, and telephonic systems are well organised. In 1899, 10,885,022 letters, papers, &c., were sent through the post, an increase of nearly 1,000,000 over the preceding year.

General Notes.

PHOTOGRAPHIC CONFERENCE.—The Camera Club will hold their Photographic Conference for 1891 on Tuesday and Wednesday, April 7 and 8, in the Rooms of the Society of Arts. The chairman will be Captain Abney, C.B., F.R.S. On Tuesday evening, 7th April, there will be a Lantern Slide Exhibition.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

JANUARY 28.—CARMICHAEL THOMAS, "Illustrated Journalism." LUKE FILDES, R.A., will preside.

FEBRUARY 4.—J. EMERSON DOWSON, "Decimal Coinage, Weights, and Measures." SIR HENRY E. ROSCOE, M.P., F.R.S., will preside.

FEBRUARY 11.—SIR ROPER LETHERIDGE, M.P., "The Proposed Irish Channel Tunnel." The DUKE OF ABERCORN, C.B., Vice-President, will preside.

FEBRUARY 18.—COL. SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S. "Methods and Processes of the Ordnance Survey." The ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

FEBRUARY 25.—E. J. RAVENSTEIN, "Colonisation and its Limitations." Sir RAWSON RAWSON, K.C.M.G., will preside.

Papers for which no dates have as yet been fixed:—

"The Sources of Petroleum." By WM. TOPLEY, F.R.S.

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"The Use of Petroleum in Prime Motors." By WILLIAM ROBINSON.

"Electricity in relation to the Human Body." By H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D.

"Milling Machinery." By J. HARRISON CARTER.

"Harbours, Natural and Artificial." By F. H. CHEESEWRIGHT.

"The Durability of Pictures Painted with Oils and Varnishes." By A. P. LAURIE.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock:—

FEBRUARY 17.—COMMANDER V. LOVETT CAMERON, C.B., "Chartered Companies in Africa."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Papers for which dates are not yet fixed:—

C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

LEWIS ATKINSON, "The Diamond Fields of South Africa."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

FEBRUARY 26.—ROBERT GORDON, M.Inst.C.E., "The Economic Development of Siam." SIR CHARLES EDWARD BERNARD, K.C.S.I., will preside.

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. the LORD REAY, G.C.S.I., G.C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

JANUARY 27.—WILLIAM SIMPSON, "Lithography: a finished chapter of Illustrative Art." SIR JAMES D. LINTON, P.R.I., will preside.

FEBRUARY 10.—HEYWOOD SUMNER, "Sgraffito." CHARLES BARRY, F.R.I.B.A., will preside.

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

CANTOR LECTURES.

The following Course of Cantor Lectures will be delivered on Monday evenings at Eight o'clock :—

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments."
Three lectures.

LECTURE I.—JAN. 26.—Introduction—Division of subject—Importance of the Violin family—The Violin, Viola, Violoncello—The Double Bass—The beauty and varnish of Cremona Violins—The chest of Viols, Viola da Spalla, Viola da Gamba, Viola d'Amore—Modern commercial manufacture of the Violin—The Harp, the Guitar, Bandurria and wire-strung Guitar or Zither—The Mandolines, the Lute, Archlute, Theorbo, Chitaronne.

LECTURE II.—FEB. 2.—Wind Instruments—Recent date of modern orchestra—Improvements of Wind Instruments in the present century—The Wood Wind: Flute, Oboe, Bassoon, Clarinet—Characteristic tone quality not due to material employed—Boehm's Flute—Seventeenth century family of Recorders—The Oboe and Bassoon Reed—Its antiquity—Difference of cylindrical and conical tubes—Seventeenth century family of Oboes—The Oboe di Caccia, Oboe d'Amore, Cor Anglais—The Sarrusophones—Seventeenth century family of Cromornes—The Bagpipes; Syrian Scale—The Clarinet, acoustic peculiarity—The Clarinet Reed—The Bassett Horn and Bass Clarinet—The Saxophones—The French Horn—Valves or Ventsils—The Trumpets and Trombones—Bach's Trumpet parts—Seventeenth century family of Cornets or Zincken—The Serpent, Basson Russe, Ophicleide—The Tubas and Saxhorns—Euphonium—Bombardon—Contrabass—Cause of modern rise in pitch.

LECTURE III.—FEB. 9.—Instruments grouped by the adaptation of a Keyboard—Its service to composition—History of the Keyboard—The early Organ—The Drone—Drawings of early portable Organ Keyboards—The Cantigas de Santa Maria—Keyboards in Italian and Flemish paintings—Summary of early large Church Organs from Praetorius—The long measure bass—The short measure or short octave—The mixture—Its dissection into registers—The pedal Keyboard—Sketch of a complete Organ—The Regal—The Harmonium and American Organ—The Echiquier and the precursors of the Piano—The Pianoforte.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. J. Hipkins, "The Construction and Capabilities of Musical Instruments." (Lecture I.)
Lantern Society, 20, Hanover-square, W., 8 p.m.
Mr. C. Harrison, "The Civilisation of Egypt and

Assyria, as illustrated by its Physical Remains and Records."

Actuaries, Staple Inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m.

Mr. Edmund Gosse, "British Ballads."

TUESDAY, JAN. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. William Simpson, "Lithography: A Finished Chapter of Illustrative Art."

Royal Institution, Albemarle-street, W., 3 p.m.

Prof. V. Horsley, "The Structure and Functions of the Nervous System." (Lecture II.) "The Spinal Cord and Ganglia."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. Fred. Spencer, "Machine Stoking."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Monthly Technical Meeting.

Anthropological, 3, Hanover-square, W., 8½ p.m.
Annual Meeting. Address by the President, Dr. John Beddoe.

Society of Architects, St. James's-hall, Piccadilly, W., 7½ p.m.

WEDNESDAY, JAN. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Carmichael Thomas, "Illustrated Journalism."

United Service Inst., Whitehall-yard, S.W., 3 p.m.
Lieut.-Col. W. T. Dooner, "Recruiting."

Royal Society of Literature, 20, Hanover-square, W., 8 p.m.

THURSDAY, JAN. 29...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m.
Dr. Norman Moore, "The History of Medicine in London."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Philip H. Newman, "The Chronology of Costume."

Royal Institution, Albemarle-street, W., 3 p.m.
Mr. Hall Caine, "The Little Manx Nation." (Lecture II.)

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Annual Meeting. 1. Mr. Bernard Dawson, "Some Different Forms of Gas Furnaces."

2. Mr. Walter Bagshaw, "The Mechanical Treatment of Moulding Sand." 3. Fourth Report of the Research Committee on Friction: Experiments on the Friction of a Pivot Bearing.

FRIDAY, JAN. 30...Mechanical Engineers, 25, Great George-street, S.W., 8½ p.m. Annual Meeting. Reading and discussion of papers continued.

United Service Inst., Whitehall-yard, 3 p.m. Lieut. and Quarter-Master P. J. Thorpe, "Cooking and Messing for the Army."

Royal Institution, Albemarle-street, W., 8 p.m.
Weekly Meeting, 9 p.m. Lord Justice Fry, "British Mosses."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. Edmund L. Hill, "The Counterbalancing of Locomotive Engines."

Sanitary Institute, 14A, Margaret-street, W., 8 p.m.
Sir Douglas Galton, "Ventilation, Warming, and Lighting."

Browning, University College, W.C., 8 p.m.

SATURDAY, JAN. 31...Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Martin Conway, "Pre-Greek School of Art." (Lecture II.)

Journal of the Society of Arts.

No. 1,993. VOL. XXXIX

FRIDAY, JANUARY 30, 1891.

*All communications for the Society should be addressed to
the Secretary, John-street, Adelphi, London, W.C.*

NOTICES.

CANTOR LECTURES.

The first lecture of the course on "The Construction and Capabilities of Musical Instruments," by Mr. A. J. HIPKINS, F.S.A., was delivered on Monday evening, 26th inst.

Examples of the instruments described in the lecture were exhibited by Messrs. S. and P. Erard, Messrs. W. E. Hill and Sons, and Mr. Arnold Dolmetsch; and quartets were performed by Mr. Dolmetsch and his pupils on viols and viola da gamba, as well as on violins and violoncello.

The lectures will be printed in the *Journal* during the summer recess.

POPULAR AFTERNOON LECTURES.

The Council have arranged for a course of five popular lectures to be given by CAPTAIN W. DE W. ABNEY, C.B., D.C.L., F.R.S., on The subject will be "The Science of Colour." the following Friday afternoons, at half-past four o'clock—February 13, 20, 27, March 6, 13. The lectures will be of a popular and elementary character, and will be fully illustrated by experiments.

The regulations for admission will be the same as for the Cantor Lectures, each member having the privilege of admitting one friend.

Proceedings of the Society.

INDIAN SECTION.

Thursday, January 22, 1891; SIR THEODORE C. HOPE, K.C.S.I., C.I.E., in the chair.

The paper read was—

HALL-MARKING OF SILVER PLATE,
WITH SPECIAL REFERENCE TO
INDIA.

BY EDWARD J. WATHERSTON.

The year 1890 marked a new era for the trade of the silversmith. The plate duties, unanimously condemned by a Select Committee, a Royal Commission, and by successive Chancellors of the Exchequer, were at last abolished, and, although a year has not yet elapsed, the beneficent effect of the reform is apparent to, and freely acknowledged by, all engaged in the trade.

Not only has the volume of trade increased enormously, as can be testified to by the various assay offices, but already marked improvements in design and workmanship are observable. Workmen are in full employ, wages have risen, and the trades which mainly rely upon the silver trade, such as engravers, plate-chest makers, and others, have participated in the general prosperity. The output of British silversmiths, during the period from 1876 to 1890, averaged 793,356 ounces per annum. It may fairly be expected that this amount will be more than doubled in the current year. All goes to prove, if proof were wanting, that there is no enemy to commerce so great as the exciseman, and no surer means whereby to dwarf enterprise than by imposing a tax upon manufactures.

In the face of such prosperity, it will not be surprising if the advocate of further reform be met with the rejoinder, "let well alone." Indeed, there is some reason for such an argument, seeing that the trade is said to be working at its full strength. Under a pernicious system of taxation, with wages at a low rate, and but few workmen on full time, no inducement was offered to bring up sons to the craft. Many—far too many—of the best hands had emigrated to America. But now more masters want more men, with the natural economic result, a rise in wages, and an eager demand for apprentices. Any reform, therefore, which has for its object an increase of trade would, at first sight, appear to be premature, even though its principle were approved. I do not hold this view; and the object of this paper is to expose its fallacy, and to press forward the work of reform to its utmost limit, under a conviction that its ultimate effect will be to restore the British silver trade to its proper position among the fine art crafts of the country.

It will be well first to consider the position

of the British trade as at present affected by legislation. I shall next proceed to show the position of the trade in foreign countries as affecting that of the United Kingdom, and, lastly, I shall plead for a thorough reform of our national system of Hall-marking.

THE UNITED KINGDOM.

By the abolition of the plate duties, the Hall-marking laws are now, practically, in the same condition as they were in the year 1784, the birth year of the duties, subsequent legislation being mainly of an amending character, abolishing the death penalty and substituting other and less arbitrary punishments for offences, providing for the Hall-marking of gold wares of low standards, &c., the principal governing enactments being now the Statutes 12 Geo. II, c. 26, and 7 and 8 Vic. c. 22. But practically, the law with regard to silver is the same as in 1784, and therefore but little differing from that of 1327, the date of the first charter granted to the Goldsmiths' Company, which, again, differed but little from the Act of 1300, 28 Edw. I. c. 20, commonly called "*Articuli super cartas*," which enacted that "no plate whatsoever should be made of a lower quality than standard (money), and that no vessel of silver depart out of the hands of the workers until it be assayed by the wardens of the craft, and marked with the leopard's head, the said wardens being empowered to go from shop to shop among the goldsmiths, and to seize in the king's name any gold wares below the 'touch' of Paris."

The exportation of plate (treasure), of gold or silver was, at that time, and for centuries after, a capital offence, without benefit of clergy. For our present purpose, very little need be said about gold plate, which is but rarely made; occasionally a snuff box, or presentation casket. Jewellery (gold and silver) is practically free, under a voluntary system of marking, at a very trifling expense. Plain gold rings are liable. Any novelty not specially mentioned in lists of exemptions, 12 George II, c. 26 and 30 Geo. III. c. 31, is liable. Enterprise is therefore checked accordingly. But, confining myself to plate (*i.e.*, unexempted wares), gold or silver, nothing whatever may be manufactured, either for home use or for exportation, below the authorised standards—of gold there are five, of silver there are two—and everything must be Hall-marked, either by the Goldsmiths' Company of London, or by one of the assay offices legally appointed. The Goldsmiths' Company, as has been shown,

was incorporated in 1327. The assay office of Edinburgh is a very ancient institution, under charter of James VII., granted in 1687, which confirmed a previous enactment of James VI. The celebrated George Heriot was a deacon of the craft in 1591. The Glasgow assay office was established in the reign of George III. Charles II., by charter, incorporated the Goldsmiths' Company of Dublin. York, Newcastle, Lincoln, Norwich, Bristol, Salisbury, and Coventry were appointed by Henry VI., which powers were confirmed to York, Exeter, Bristol, Chester, and Norwich by William III., and to Newcastle by Queen Anne. Birmingham and Sheffield were added by Geo. III.

Some of these have ceased to exist. Some others are said to be on their last legs, the amount of business transacted not being enough to cover expenses, now that the duties are abolished, upon which they used to have a commission—1 per cent. in England, 2½ per cent. in Scotland, and 5 per cent. in Ireland. Norwich, Bristol, Exeter, and Newcastle have long since given up. It is difficult to see how Edinburgh, Glasgow, and Dublin can pay expenses; so that, unless the Government undertake responsibility—a proceeding very unlikely to commend itself to the House of Commons—there remain only London, Birmingham, Sheffield, and Chester at which, ere long, Hall-marking facilities will be available. That Hall-marking must be a self-supporting institution, or must cease to exist, is, I suppose, unquestionable. On the other hand, that manufacturers of plate in Scotland and Ireland should be handicapped by the compulsory inconvenience, delay, and expense of sending their productions to England to be marked, would be impolitic in the extreme. Both countries in the past have been remarkable for silver work, as may be seen in collections of antique plate at home and abroad. The decadence of the art in Ireland may be due, in some measure, to the poverty unhappily prevailing, but I am convinced that it commenced as a result of taxation, and that under freedom a revival of the art is not only possible but highly probable. At all events, an absence of marking facilities would seem to present a strong argument in favour of a voluntary system for those countries. The substitution of a "trade mark," protected as it would be under the Merchandise Marks Act, on the part of manufacturers, together with a stamp "Sterling—925/1,000ths," as in America, would answer all the purpose. There is but one alternative *viz.*, for the English assay offices to adopt the

principle of "the touch" in place of "the scrape and parting assay," in the case of finished goods, of which hereafter. Manufacturers could also, if they liked, place Scotch or Irish emblems upon their goods, further to denote the locality of manufacture. One condition I hold to be essential for the trade, viz., that nothing shall prevent it being carried on in any part of her Majesty's dominions, and I see no distinction whatever between plate and jewellery: if jewellery be free, so ought plate to be free.

INDIA.

Passing to foreign countries, I take India first, as being the subject of most interest to members of this Section of the Society of Arts, a society which I always like to call by its full name—"The Society for the Encouragement of Arts, Manufactures, and Commerce." I have a great belief in British commerce, viz., our trade relations with foreign countries. The influence of this Society is, to my mind, never better exercised than in encouraging those relations, most especially with our colonies and dependencies.

It is most important that it should be thoroughly understood in India that there is now freedom of trade in all wares composed of the precious metals, as between that country and the United Kingdom. The same may be said with regard to all oriental countries, and in point of fact to all countries, oriental or occidental, if, in the case of plate, wares be of "oriental" design. By the Revenue Act of 1884, it was enacted that "foreign plate which, in the opinion of her Majesty's Commissioners of Customs, may be properly described as hand-chased, inlaid, bronzed, or filigree work of oriental pattern, shall be exempted from assay in the United Kingdom." In point of fact, the voluntary principle has been conceded to such (foreign) wares; if they be of full standard quality, they can be sent for assay at discretion of importer, or they can be offered for sale as they are, irrespective of quality. The advantage to India is this—importers can now feel the pulse of the British market at a simple cost of carriage and agency. It remains to be seen whether advantage will be taken of the trading facilities open to them. It cannot, however, be denied that India still has to contend with certain disadvantages. In the first place, buyers in this country attach great importance to the Hall-mark. Its absence is suggestive of doubts as to quality. Secondly, Indian plate, as a rule, is

of rupee standard—'916—and thus it cannot be marked in this country without an alteration of law. Thirdly, if it be of standard quality—'925—or if the law be altered, instituting a new standard for foreign plate, say '900 (fully to allow for solder), it cannot be marked, excepting under the system of the "scrape and parting assay," a process which, especially in the case of Indian plate, is fatal to the finish of goods, involving a return to a workshop inevitable.

The subject is thus regarded in India :—

"The most serious difficulty hitherto in subjecting goods to the English assay has been, that the nature of that assay is such that the goods are materially injured in the process. Hence, it is necessary to send the goods to the assay office in an unfinished state, and, after they have been marked, to take them back to the workshop and finish them for sale. This cannot be done with Indian wares."

Of course, this difficulty could, and, in my judgment should, be got over at once. There is no sort of difficulty in France or in Austria, or in many other parts of the continent, Hall-marking being carried out by the "touch," a process although not so accurate as the "parting assay," is sufficiently so for trade purposes.

There is a strong argument against the introduction of a new standard, granting the dignity of a Hall-mark to plate below that of the United Kingdom, but the objection is not insuperable; it has already been done in the case of gold, which can now be marked of 9, 12, and 15, as well as of 18 and 22 carats fineness. There is, therefore, no logical objection to the introduction of a lower standard in the case of silver. The objection may be said to be sentimental rather than practical. Most continental countries have a standard of '900, many, indeed, France for example, marking '800; Spain even '738.

If it be held to be necessary, in the interests of India, to alter the law, it would appear to be desirable that it should be done at once; but such alteration must be accompanied by the introduction of the "touch," in place of the "scrape and parting assay," under a voluntary system, as provided by the Revenue Act of 1884. It may be well to state that I have had experience of marking by the "touch" in Paris and Vienna. Finished goods are marked, in a few minutes, without the smallest possible injury to work, however elaborate. It is much to be regretted that Goldsmiths'-hall has not, long ago, taken steps legally to adopt a similar system.

I now turn to the proposal, on the part of

Mr. Goschen, to establish a system of Hall-marking in India for goods intended to be introduced into the United Kingdom, a proposal which, as might be expected, has met with considerable opposition, not only on the part of the Indian Government, but also on the part of native manufacturers.

The proposal, doubtless well intentioned, under an earnest desire to open the British market to her Majesty's Indian subjects is, to my mind, altogether impracticable. Such evidently is the well-considered opinion of the Indian Government. "No compulsory system" (I quote the opinion of the Indian Government), "would be possible in India. No system of assay, under Government regulation, has ever been in operation in that country; it is not now desired by the trade in India, or by the purchasers of Indian gold and silver wares, and it would necessarily operate unequally and unfairly in a country of long distances, costly transit, and wide distribution of manufacture." Again, the questions of locality of Hall-marking centres—in India there are only two mints (Calcutta and Bombay)—and of fees to be paid, present, as it seems, insuperable objections to the establishment of assay offices. A glance at a map of India should decide the first question at once, and the second is decided by the fact that no reasonable fee could possibly pay expenses, if marking were confined only to goods intended for exportation. It must be recollected that the vast body of Indian silversmiths are of the small trader class, spread over the vast empire. The silver used by them, from time immemorial, is obtained by melting rupees; the solder is necessarily of an inferior quality, and every worker is "a law unto himself," both as respects its quality and quantity. The "art" of the silversmith, in India, is regarded—not the exact quality of material. I refer to this as a conclusive proof that no hard and fast line can be drawn nearly approximating to the rupee standard. The conclusion, I submit, is that our laws must be altered, and that India should not move in the matter at all, excepting hereafter, by publishing fully the conditions under which goods can be consigned for sale in the United Kingdom when our law has been reformed. Before leaving the subject, it is important that importers should fully understand that buyers in England take but little interest in work covered over with native gods, but that they incline more and more to old English designs,

and that plain work sells more readily than that of an ornamental character.

However, whether Indian silverware will sell or not, can only be decided by experience. The policy of our Government manifestly is to provide that there shall be no legal hindrance to the enterprise by which alone that experience is to be gained. Nothing, in my judgment, would be more impolitic than for the Indian Government to move in the matter.

THE COLONIES.

As in India, so in the Colonies, no laws prevail (other alas! than Customs duties) with reference to the manufacture or sale of plate. With the exception of Canada, there is a steady, though limited, demand for home-made work. In Canada, however, our Hall-mark is objected to, for the reason that when, as good customers to England, it prevailed, it was forged by native and American manufacturers, and thus it became a byeword and reproach. The art of the silversmith is very little practised in Canada. Canadian shopkeepers as a rule, buy in America, and insist upon the mark, "Sterling—925/1,000ths," a mark easily protected in police or county-court. Provided that our law be altered, allowing us to mark as desired by Canada, this trade should at once be recoverable, seeing that we could produce plate of American style, to suit the Canadian market, at a far less price than it can be produced in America, owing to the enhanced price of labour in that country, as a result of a protectionist policy. The Government should understand that, so long as we have a compulsory system of Hall-marking in the case of goods intended for exportation, no trade with Canada is to be expected. With regard to plate imported into this country from our colonies, it may be observed that, although a voluntary system of Hall-marking has been conceded to foreign plate of "oriental" design, Australian silversmiths are still under the principle of compulsion. This is a subject seemingly of interest to the Colonial Department. The colonies should demand to have equal facilities extended to them as have already been, or may be, extended to India.

THE UNITED STATES.

The tariff alone suffices to prevent any great development of trade. However, it is satisfactory to note that, even in the face of a tariff intended to be prohibitive, trade is done with the United States, no objection being made to our Hall-mark; in point of fact, perhaps, the

Hall-mark encourages sales. No law (other than fiscal) prevails in the States. Our standard has been adopted; and the best work is always stamped "sterling—925 1,000ths." Manufacturers in this country need not fear American competition, either in their own or other markets, prices being prohibitive. This has been proved to be the case in Australia, where, some years ago, Americans tried to introduce their goods. In Paris, Vienna, Moscow, and St. Petersburg, Americans are doing good business. At the last Paris Exhibition, a large business was done by American firms with wealthy foreigners of all nationalities, showing that, with some buyers, price is no object; the greater the reason for a reform of our laws, so as to permit competition by our manufacturers. Throughout the Continent, richly chased work, and expensively modelled work—a result of a proper system of education on the part of the workmen—find ready sale.

THE CONTINENT.

Lately, there has been published a Parliamentary paper entitled "Foreign Countries (Gold and Silver Marking)" which should be of great interest to British silversmiths. We are now in possession of all the facts relating to the laws and regulations with regard to the manufacture and sale of plate in Austria, Hungary, Belgium, Denmark, France, Germany, Italy, Holland, Portugal, Russia, Spain, Sweden and Norway, and Switzerland. A glance at this report should show manufacturers why our export trade is so limited. During the last fourteen years, our total exports to all countries have averaged only 92,569 ounces per annum, and the "Statistical Abstract" tells us that our exports to the continent have been a mere bagatelle, a fact attributable alone to the impolicy of our Hall-marking laws. It is now on record that foreign standards all differ from ours, and, for the most part, theirs from each other, and that most countries have strict Hall-marking systems of their own, based, of course, upon their own standards. Therefore, foreigners want neither our standard nor our Hall-mark. In no Continental country is the tariff in any degree prohibitive. In France, the duty upon imported silver plate is exactly the same in amount as that levied upon home-made work, about 6½d. per ounce, including the Hall-marking fee. Finished goods are marked by the "touch." With but few exceptions, all

the standards are lower than ours. Even those exceptions are a disadvantage to this country. France marks '800 and '950, so British goods, being '925, are re-marked in France with the stamp denoting the lower standard. In Austria, our plate is re-marked as '900.

But, the great point of interest to British silversmiths is to be found in the fact that, however strict foreigners may be with regard to plate exposed for sale in their own country, with the exception of Holland, Portugal, Russia, and Switzerland, they all permit their manufacturers to make anything they like, of any quality ordered, for exportation, and Russia encourages exports by remitting half the Hall-marking fees.

So the British position is this: foreigners may make what they like for us, and, provided it be '925, it can be imported into this country, and can be Hall-marked at an expense of a few pence; or, if it be for private use or of "oriental" design, it can be imported, of any quality, free from any obligation of assay; whereas the British silversmith cannot make an ounce of plate for a foreigner unless he be prepared to take our standard and our Hall-mark. Dealers in the United Kingdom may buy, and expose for sale, foreign-made plate, which, "in the opinion of Her Majesty's Commissioners of Customs" is of "oriental" design, without the obligation of Hall-marking; but if a manufacturer in this country make exactly similar plate, he and the dealer are to be fined £10 each, unless such wares be Hall-marked. Imports here are permitted and encouraged; exports practically are prohibited—at all events, are permitted only under conditions as render trade, in many instances, impossible. The impolicy of this practice, I think, is undeniable. If there be one thing more than another which shopkeepers desire to conceal, it is the origin and locality of manufacture. Shopkeepers abroad might be induced to give large orders to British manufacturers, but when they got possession of the goods they would be very unlikely to proclaim them as British. They would get them marked in France, Russia, Austria, or elsewhere, and sell them as of their own production. Hence a natural objection to the British Hall-mark. The policy of this country, as it seems to me, is to encourage all business which shall provide work for our workpeople, and to make for foreigners anything that they may be disposed to order.

CONCLUSION.

To conclude, I submit that the time has arrived for a thorough reform of our laws. It is a recognised fact that Hall-marking, one of the most ancient institutions of this country, is a good one, and there is not the slightest proposal for abolishing it; but it should no longer be compulsory. At present it is partly voluntary and partly compulsory, with the effect that, during the last ten years, 4,570,000 ounces have been marked under the former principle, and 6,600,000 ounces under the latter—the former simply under the law of supply and demand. The argument is manifest that, if the public demand and get a mark in the one case, they would get it in the other. One result of reform would be to open the export door, now closed, to British enterprise. But, under a system of freedom, new uses might be found for silver, not necessarily of standard quality. Furniture might be ornamented with silver; silver might be used artistically together with other metals, a combination now illegal. Under a voluntary system further reforms would quickly follow. The “touch” has been already referred to. The practice of breaking goods sent to hall, in the event of their being below standard, is a relic of barbarism, and should be abandoned; it would be unnecessary under a voluntary system of marking. The “date” mark is objectionable; it simply proclaims goods to be “old stock,” if they be not quickly disposed of. True it is that the second-hand dealer of to-day trades upon “old marks,” to the delight of collectors, and that Elizabethan plate, however ugly, has a trade value of £20 per ounce, as a result of the mark alone. Personally, I enter a protest against perpetuating a system only useful to second-hand dealers of future generations.

“As though there were a tie,
And obligation to posterity,
We get them, bear them, breed and nurse;
What has posterity done for us
That we, lest they their rights should lose,
Should trust our neck to gripe of noose?”

Far better that we should leave to posterity good work, of really artistic merit, than work, the only value of which is comprehended in a date mark.

The “locality” mark is even more objectionable, as, practically, it creates a monopoly for the London mark, which is preferred by dealers, as signifying “London made.” Sheffield manufacturers constantly send goods to be marked in London, so that they may be sold as “London” made. The trade stipu-

lates for the “London” mark.” The maker’s mark is also open to objection. At present, if there be several partners in a firm, the initials of all the partners have to be stamped on goods. A registered “trade-mark” would be far better. In point of fact, in the case of silver, all that is required is the “trade-mark” of the maker, and the “lion,” signifying standard, and, if a lower standard be adopted, some device indicating that standard. In the case of gold wares, the “trade-mark” and figures indicating the quality—22, 18, 15, 12, or 9 carats fineness, and perhaps a “leopard’s head”—would suffice. These are details best settled by the Board of Trade.

The license tax, of course, should be abolished. The only *raison d’être* of this tax was because traders dealt in excisable articles. The duties having been abolished, there is no *raison d’être* whatever.

Lastly, a new Act of Parliament is required. At present, the trade is governed—I would suggest misgoverned—by at least thirty-eight unrepealed enactments. This, again, is a matter for the Board of Trade, and, if the Board be of the same opinion now as when Sir Thomas Farrer and Dr. Giffen represented it before the Select Committee of 1878-9, it cannot be doubted what sort of Act the new Act will be. That it will be drawn upon the lines of freedom of trade is assured. It will be a reforming Act. I plead only for reform. I plead for what will be, practically, perfect freedom of trade in the precious metals. Of course, no new country would propose to regulate the gold and silver trades by law. But I am reminded of the wise words of Lord Macaulay:—

“The world is full of institutions which, though they ought never to have been set up, ought not to be rudely pulled down, and that it is often wise, in practice, to be content with the mitigation of an abuse which, looking at it in the abstract, we might be impatient to destroy.”

APPENDIXES.—No. 1.

THE FOLLOWING TABLE SHOWS THE VARIOUS STANDARDS OF GOLD AND SILVER IN THOUSANDS.

<i>The United Kingdom.</i>		
Gold.		Silver.
917	.....	959
834	.....	925
750	.....	—
625	.....	—
500	.....	—
375	.....	—

Austria-Hungary.

•920	•950
•840	•900
•750	•800
•580	•750

Belgium.

•800	•900
•750	•800

Denmark.

•585	•826
------------	------

France.

•920	•950
•840	•800
•750	—
•583	—

Germany.

•583	•800
------------	------

Italy.

•900	•950
•750	•900
•500	•800

Holland.

•916	•934
•833	•833
•750	—
•583	—

Portugal.

•916.66	•916
•800	•833
For exports } 333	•800

Russia.

•990	•910
•920	•880
•820	•840
•720	—
•560	—

Spain.

•916	•916
•750	•750
—	•738

Sweden and Norway.

•968	•820
•833	—
•750	—

Switzerland.

•750	•875
•583	•800

No. 2.

Hall-marking is a voluntary institution in Belgium, Denmark, Germany, and Italy. In Austria, Hungary, France, and Sweden and Norway, it is voluntary for exports. In Spain, imports and exports are free. In Holland, a full drawback of duty is allowed upon exports. In Russia, half the Hall-marking fees are returned upon goods intended for exportation. The only countries in which Hall-marking is obligatory, alike for home use and exportation, are the United Kingdom, Holland, Portugal, Russia, and Switzerland.

No. 3.

Assay by the "touch," especially in the case of finished goods, is the practice in Austria, Hungary, Belgium, France, Italy, Holland, Portugal, Russia, Spain, and Switzerland.

No. 4.

As has been stated, the tariffs of foreign countries are very small, in most cases, as in France, being the same as the duties payable upon home-made goods. In Denmark, Sweden, and Norway, commercial travellers showing patterns have to take out a license to trade, and to pay duty upon those patterns, which duty is returned when re-passing the frontier.

DISCUSSION.

SIR GEORGE BIRDWOOD said:—I really have nothing to say, to justify my responding to the courteous invitation of the chairman to open the discussion this evening, unless it be to take advantage of the opportunity offered me to express, as I am sure I may do, on behalf of the Indian Section of the Society of Arts, the pleasure it has given us to be addressed by Mr. Edward Watherston on a subject which he has so completely made his own. The abolition of the duties on gold and silver plate is a great thing to have accomplished, and of Mr. Edward Watherston it may be said, with literal truth, "Alone he did it!" I well recollect the first meeting he called, in October, 1876, to agitate the question, and the scorn and derision with which he was assailed for it by his brother craftsmen in this country. Failing in his appeal to "the trade," Mr. Edward Watherston then commenced his series of incisive letters in the *Times*, and these at once made a deep impression in India; and ever since then he has found in the Indian authorities his best allies in the movement with which his name will always be so honourably associated. In 1877, he read his notable paper before the Social Science Congress at Aberdeen; and it had an immediate effect on public opinion in this country. In fact, the paper received the cordial support of the whole Press of the United Kingdom, except, if I remember rightly, the *Pawnbrokers' Gazette*. In 1878, Sir Stafford Northcote gave Mr. Watherston a Select Committee, and

its report, published in 1879, was the death-knell of the plate duties. In 1881, Mr. Edward Watherston read his paper, based on the report of the Select Committee, before the British Association at York; and followed it up by a ceaseless succession of letters to the *Times* and other newspapers, until the duties were finally abolished last year by Mr. Goschen. Looking through my boxes at home, and at the India-office to-day, I calculated that Mr. Watherston has written in the *Times* and other leading journals, not less than 1,000 letters in advocacy of the abolition of the duties. Passing to this evening's paper, I will frankly express my regret that it is not treated with the encyclopædic elaboration of detail Mr. Watherston could easily have given it, and which would have made it invaluable for ready reference in future; but in every line it bears the stamp of a writer who is a thorough master of his argument, and its interest is probably enhanced by its being less an historical and statistical exposition of the questions with which it deals than a trenchant expression of Mr. Watherston's well-matured views and opinions on them. After all, for practical purposes, that was probably the preferable form to give his paper. I am still, in spite of the great weight of opinion on the other side, a warm supporter of Hall-marking. I have therefore been particularly gratified, while hearing Mr. Watherston read his paper, to find how much he has modified his old opposition to this sound and salutary usage of his ancient craft. In fact, it seems to me that Mr. Watherston no longer really objects to Hall-marking. He advocates the stamping of gold and silver plate with their actual degree of fineness, only he would prefer the use of private stamps for the purpose to any official stamp, such as that of the time-honoured Goldsmiths' Company of London. Surely, if there is to be any guarantee mark of genuineness on gold and silver plate, every purchaser would prefer an official stamp, or "Hall-mark" as we call it, to a manufacturer's own punch-mark. No one would ever dream of appealing against the former, while the latter would always be subject to suspicion, demurrance, and delay. True Mr. Watherston says that he would not make "Hall-marking" any longer compulsory, and would allow it to be voluntary. But this is quite an illusory qualification, and should impose on no one. If there is to be a guarantee stamp, that is a "Hall-mark," at all, no manufacturer of gold and silver plate could avoid using it without thereby at once standing self-condemned. In fact, it is sheer absurdity to talk of voluntary "Hall-marking." Mr. Watherston tells us that voluntary "Hall-marking" exists already. Yes, but that is in respect to jewelry, which is legally exempt from it; because in jewelry the artistic elaboration, and therefore worth of the work is out of all proportion to the value of the gold and silver employed on it. No honest purpose, therefore, would be served by "Hall-marking" jewelry; and in fact, if I ever find it "Hall-marked," I always suspect some sinister intention in so ostentatious a piece of super-

erogation. On the other hand, in regard to plate we must insist on "Hall-marking," or "guarantee marking" of some kind or other. Gold and silver are recognised among all civilised people as the most convenient representatives of value, and no prudent person would ever think of purchasing gold and silver plate without reference to their bullion value, that is, the standard of purity of the articles, irrespective of their artistic merit; and it is of the first importance, therefore, to provide the public with the means of quickly and accurately ascertaining their intrinsic worth; and this can be done only by some such system of Hall-marking as has been in use in England for nearly 600 years; and possibly from the time of the Roman conquest of the country. The present system no doubt requires modification. We have five marks on our plate. The first is the "duty mark," the sovereign's head, and that, of course, goes off with the abolished duties. The second is the mark of the standard of purity. This is the "lion passant," for gold of the old standard, 22 carats, and sterling silver of 11 oz. 2 dwts.; and there are other distinguishing marks for the gold and silver of the new standards of 1845. These standards require some modification to meet the necessities of India and the colonies; and I would also adopt the continental plan of expressing the standards of purity, or degrees of fineness, in thousandth parts; but, as far as possible, the old historical standard marks should still be retained. The third is the "Hall-mark," or official stamp, which, in England, can be applied at Birmingham, Chester, Exeter, London, Newcastle, Norwich, Sheffield, and York; in Scotland, at Edinburgh and Glasgow; and in Ireland, at Dublin. Surely these are enough centres of official stamping to suit the convenience of every manufacturer in the United Kingdom; and they could be easily multiplied. It is useless to complain of local manufacturers having to go a long distance to obtain a "Hall-mark," when, in the same breath, Mr. Watherston tells us that Sheffield manufacturers send their wares voluntarily to be stamped in London, instead of at Sheffield, where an assay office has existed ever since 1873-4. The "Hall-mark" of the London Goldsmiths' Company is the famous "leopard's head." The fourth is the "date mark," which, in the United Kingdom, is everywhere a letter of the alphabet. Mr. Watherston would remove it, because he says it is of no use except to dealers in second-hand plate. But they are a most important body of men, and are growing every year in importance, and not only because there is nothing which purchasers more prize in plate, after its genuineness, than authentic proof of its date of manufacture, but also because, in every British industry, we seem, now-a-days, to be failing in the competition with Continental manufacturers, and so are becoming more and more dependent on second-hand trade. The fifth, and last mark on plate, is the "maker's." This is generally his initials. Initials are not artistic,

especially where there are many of them; and I would allow the use of a trade-mark instead; and I would insist on a mark identifying the actual place of manufacture being combined with the maker's mark. I would do this, not only to invest articles of plate with one more charm of historical association, but to stimulate local pride in the productions of our manufacturing towns. In every way we should seek to encourage personal pride, local pride, and national pride in our home manufactures, as the very best means of promoting their genuineness and artistic character. The place mark should be the borough arms. Hall-marking of some description is absolutely necessary in India if that country is to derive any great advantage from the abolition of the plate duties; and if it is not insisted on now that these duties have been removed, the indigenous goldsmiths' art in India, except as regards jewelry, will be rapidly destroyed, just as the Indian carpet-weaving industry has been. The native manufacturers of gold and silver plate in India are not the exporters of it; they simply execute orders for the exporters, who mostly are Englishmen. In working for their own people the native goldsmiths use gold and silver of absolute purity. They are bound to do so by the force of their religion—*i.e.*, the ritualistic obligations of their sacro-sanct craft: and also by the thorough knowledge every Hindu possesses of the quality and value of the precious metals. In appraising gold and silver work and gems, a Hindu or Parsi lady will not err one per cent. in values of thousands and tens of thousands of rupees. But it is quite different when the native goldsmith works for foreign exporters. Then he has no standard of purity binding on him, and the exporter is, in most cases, entirely at his mercy. This has been shewn to be the case over and over again; and exporters at Calcutta, Madras, and Bombay naturally shrink from the risk of sending Indian gold and silver plate to England, which on reaching the Customs-house may be condemned and returned upon their hands. Already, on this account, Indian silver has become greatly discredited in this country; and that discredit would never be removed by abolishing Hall-marking altogether. If that were done, the manufacture of plate in India would be concentrated in foreign houses at Calcutta, Madras, and Bombay; and the native goldsmiths all over the country would be starved to death, and their art perish with them. No, the proper course is to multiply, as on the Continent, the standards of purity of gold and silver, and down so low as five-hundred thousandth, or one-half the intrinsic fineness of the metal; and to establish assay offices at Calcutta, Madras, Bombay, and other convenient centres such as Lahore, Delhi, Kurrachee, &c., for the authentication of any plate brought to them; this being compulsory only for articles for the export trade. No Hall-marking is needed for native Indian purchasers, unless for those of them who, in consequence of their having received an English education, have lost the accomplishments of their vernacular

culture. As already said, Hall-marking is not required for jewelry, which forms the bulk of the goldsmiths' wares purchased by Anglo-Indians in India. The assay in India can be indefinitely simplified; and if native Indian assayers were employed, the "touch" test might be absolutely relied upon. I have not only had as great an experience as almost any London goldsmith in dealing in plate—all of it Indian plate, of course—but I have largely manufactured it myself, in the sense of having for years had numbers of native Indian craftsmen employed under my responsible superintendence, in the production of articles of plate and jewelry; and I always found that I could rely on the "touch test," in their hands, as implicitly as on the Bombay Mint assay. The same standards should be used in India as in England, and the same standard and date marks; and similar Hall, and makers, and place marks. Care only should be taken that the new marks for the new standards should include such as are objects of veneration among the Hindoos; up to which they would therefore instinctively desire to raise the purity of the gold and silver wrought by them. Such marks would be the *fleur-de-lis* [Welsh leek], the shamrock, the trident, the lotus, wheel, and *swastika*; and some of these sacred emblems should stand for the highest standards of fineness in gold and silver. The "Hall-marks" used at Calcutta, Madras, &c., should also be distinctively Indian, as the elephant, tiger, peacock, and cobra; and of course, the mark of the place of manufacture, and maker's mark would, if used at all, be Indian in character. Let all those who would refrain from introducing Hall-marking in India just think of the convenience its adoption would be to the exporter of Indian plate into the United Kingdom. All his hesitations, anxieties, and risks would at once be at an end. The official Indian "Hall-mark," whether of Calcutta, Madras, or Bombay, &c., stamped on his goods, he would be able to export them freely into the United Kingdom, now practically closed against them, and with the certainty of obtaining a very high profit on them; on account of the cheapness with which plate of the highest artistic quality can still be made by the native goldsmiths of India. The benefit of all this to India itself would be enormous, and immediately become apparent. In a word, if we could guarantee the degree of fineness or purity of articles of plate made in India, they would hold their own against the competition of the whole world; for nowhere else can objects in gold and silver of high artistic merit be produced at so extraordinarily low a cost. In work of the minutest elaboration, it never exceeds the weight of the metal used on it expressed in rupees; while the average cost is from a quarter to one-half the weight of the metal. I feel very deeply on this question of Hall-marking. In the consideration of this and analogous questions, I have all my life instinctively identified myself with the interests and

sentiments of the people of India; and, standing in their place of artistic mastery and commercial servitude, I see clearly that if we do not protect their plate industry by Hall-marking, incalculable injury will slowly, but surely, be inflicted on them; while, if we make Hall-marking compulsory—of course for the export plate only—we may yet redeem from perdition the great goldsmith's art for which they have been immemorially famous, but which, owing to the various adverse influences of our supremacy on the sumptuary industries of India generally, has ever since 1813, when the East India Company's monopoly was abolished, been in a state of enforced decay. Hall-marking, will, I believe, provide it with a veritable Palladium. I do not approach this question from the side of political economy and statistical science, or of administrative convenience. What I see beyond and above all these weighty considerations is that if one after another you destroy the hereditary arts of a people, and their whole indigenous culture, you destroy their historical individuality; and that the paramount duty of every ruler is not so much to ensure the material prosperity of a people, as to safeguard their spiritual health, wealth, and happiness, or, in more familiar words, to save their soul alive; for the self-existent activities (industrial, literary, and religious), habits, and character of a people are the only sure foundations of national riches and greatness, and the only trustworthy guides through the deep darkness of a nation's destiny.

Mr. T. H. THORNTON C.S.I., said he had taken a great interest in this question for many years, and was one of the first in India to move in the matter of the abolition of the duty on silver plate, though Mr. Watherston had done so previously in England. Sir George Birdwood's speech, able and interesting as it was, had entirely failed to convince him that there was any necessity for compulsory Hall-marking with all its attendant inconveniences and objectionable restrictions. Sir George's main argument was the protection of the purchaser, but that would be effected by the voluntary system; he need not purchase without the Hall-mark. Then it seemed absurd to insist upon one silver standard. The standards in silver as in gold, should be multiplied to suit present requirements. Again, Sir George had advocated a number of complicated signs to indicate the locality, the name of the maker, and other details; but it seemed to him that the mark should be as simple as possible, so that any one could understand it without professional training and know at once the quality of the metal which was guaranteed, whether .925 or .900, or .800, as the case may be. The argument that the symbols were valuable as showing where an article was made, &c., seemed to be disposed of by the fact mentioned by Mr. Watherston, of Sheffield manufacturers sending their goods to London to be marked, in view to their being passed off as London made. Assay should be by touch, and scrape and parting abolished for ever,

as barbarous. He cordially agreed with all the proposals put forward by Mr. Watherston.

Mr. WILLIAM BOTLY said he had always taken a great interest in the silver-plate industry, his family having been engaged in it for four generations. He had followed Mr. Watherston's efforts from the first with great sympathy, and congratulated him on having lived to see one of his main objects accomplished—the abolition of the duty. He hoped that, with certain safeguards which he would probably see his way to adopt, his further proposal would also be carried out. Nothing should be done to restrict the manufacture or trade of this country or any other, but all existing restrictions should be abolished.

Sir CHARLES BERNARD, K.C.S.I., said this question was of importance to India, and he was glad to hear of the development of trade which had followed the abolition of the duty, a point which he thought would be new to many. The Indian Section of the Society were especially indebted to Mr. Watherston for what he had done for India, and they would all join in his hope that, before long, compulsory Hall-marking would cease. He believed the silver trade in England were not unfavourable to the duty, and there was a good deal to be said for it, being a duty on a luxury purchased by the rich. He believed, therefore, that had it not been for the claims of India it would not have been removed. He went entirely with the proposal to abolish compulsory Hall-marking. The Americans did very well without it; they put the quality of the silver on the article, and they had developed a large trade in Europe in silver plate; and in Paris and other places, notwithstanding the high cost of labour in America, they had succeeded in pushing their wares to the disadvantage of English traders. It was never suggested that there should be Hall-marking over the whole of India, but if Indian plate were sent to this country, unless it were in the shape of jewelry or artistic work, it was subject to the English law, under which, if not bearing the Hall-mark, it was broken up. To get rid of the difficulty, it was suggested that at certain sea ports there should be assay offices, which should place an Indian Hall-mark on the goods that exporters might present for assay; such a Hall-mark was to free the goods from liability to the British Hall-marking rules. That would certainly be a convenience to exporters, but it would be much better for the compulsory system to be abolished altogether. The object was to render it easy for the Indian trader to export his goods to England; but the great majority of Indian silversmiths were small men, and it would be quite impossible for them to send their wares to any number of centres which could possibly be established; and if compulsory marking were insisted on, it would absolutely stifle this industry, which was now increasing and improving. Last year, at any rate, the general feeling of the British trade was to keep up the system

of Hall-marking, and he did not wonder at it, because restrictions of this kind always tended to keep the trade in the hands of the large manufacturers; whereas if it were removed, he believed artistic silver ware would be made in many places, even in England, where it was not made at present. So far as he could judge, the general opinion in India would accord with the views expressed in the paper. Trade marks on silver ware were not unknown in India. The firm of Hamilton and Co., jewellers, of Calcutta, had used an elephant as their trade mark for generations, and that mark was known in most parts of the civilised world as a guarantee of quality. English makers might do the same, and in this way the melancholy fate of the confiding purchaser alluded to by Sir George Birdwood would be prevented.

Mr. W. MARTIN WOOD said that having taken some part in this agitation, he congratulated the Society on the assistance it had afforded, and the results attained. But it had taken a great many years to push forward to success a cause which had been acknowledged to be a good one ever since the Report of the Select Committee of 1878. References had been made to the British and other associations through which Mr. Watherston had worked; but he should like to mention another body which, through his aid, had rendered good service, viz., the East Indian Association; the efforts of that body had told with more direct impact on the authorities, because of its Council being directly connected with India. He was sorry to be obliged to differ from such high authorities as Mr. Goschen and Sir George Birdwood on the subject of Hall-marking gold and silver plate in India; but he preferred the direct opinion of the Government of India, as quoted in the paper, which covered nearly the whole field of argument. If, however, some system of assay and marking has to be devised for India, perhaps the Chairman could say whether each collector's office could be furnished with the materials to apply the test by "touch;" if so, it might be feasible; but if it were left to be applied at the port, it would involve unpacking and repacking, and no end of trouble. He was quite alive to the risk the purchaser ran, but there were two or three obvious expedients to meet the case. First, there was the character of the makers themselves; then there was the easy method of testing by touch, which could be accomplished by any efficient chemist; and there was the Penal Code to deal with cases of fraud. It would be most unfortunate if the Indian Government were pressed, against its better judgment, to raise a new obstacle of this kind. Another objection to the introduction of the assay system was, that a great deal of silver ware came from the Native States; and it would be an unnecessary interference with their subjects to impose such restrictions.

Mr. C. PURDON CLARKE, C.I.E., said he had had a considerable amount of Indian plate pass through

his hands at different exhibitions during the last 13 years, and he had had many difficulties with it. The chief obstacles to its greater introduction into England had been the duty, in the first place, and, secondly, its uncertain quality. He knew an instance in which a regiment ordered a large silver service from Cashmir, which looked very well when it was sent down to Madras, but, after a few months' wear, it turned various colours—principally green—and, on being assayed, it proved to be a compound of all sorts of metals—zinc and lead amongst others. A complaint was sent to Cashmir, and the Maharajah went into the matter, and imprisoned one of the principal offenders. The result was that, for several years afterwards, that man made capital plate, as he could testify, having purchased several fine pieces from him. He felt the greatest respect and sympathy for Sir George Birdwood's suggestion, and there was little doubt that compulsory marking would be useful, but he could not help seeing also that there were immense difficulties in the way of doing it, except at the ports; and there the question of repacking would be a matter of expense and difficulty. Some of the best examples of silver came from out of the way places, where it would be impossible to get the makers to register their names; sometimes, even, they had no fixed residence. He could only suggest optional marking by the makers, and that the Mints at Bombay and Calcutta should assay by touch, and mark any plate brought to them at cost price. Reference had been made to the possible increased use of plate; and, in connection with that, he might mention that, only that afternoon, he had been inquiring of a large restaurant proprietor, who had been 23 years in business, the cost of the constant retinning of his copper vessels. He told him that during that time it had been more than their weight in silver, as they had to be tinned once a month, and it was a very expensive process. If there were no restrictions on the silver trade, it would therefore, in all probability, be largely used for cooking utensils; and this would lead to a greatly increased consumption. Another point worthy of notice was the great charge made by manufacturers, which no one could explain. A brass teaspoon, beautifully finished and silvered over, could be bought for 7½d. or 8d.; so that, if the value of the metal were ¾d. or 1d., the workmanship cost 7d. But you could not buy a silver spoon anywhere that was not loaded with 40 or 50 per cent. on its value. Why a silver spoon should cost 2s. or 3s. to make, especially when it was done by machinery, he could not understand, except that it was a part of an old system connected with high duties, uselessly sunk capital, and slow sale. He was quite sure that, if the makers would supply plate at more reasonable prices, they might largely develop the trade. Perhaps a more startling illustration of the present condition of the silversmiths' trade can not be found than that afforded by the attempt made by Mr. Bunghara to ensure good quality in Indian plate, by obtaining silver rolled sheet of standard

quality from England. He was unsuccessful, as the price asked for plain rolled silver sheet was more than that charged in India for shaped vessels, with a certain amount of ornament added.

Mr. F. B. THOMAS said he had been furnished with a copy of the paper on entering the room, and he had been much astonished to find that in reading it, Mr. Watherston had interpolated a variety of statements, which were not in the print, which reflected injuriously on the Goldsmiths' Company, and which he, as a member of the Craft, ventured to contradict. Such incidents as had been referred to of a number of articles being broken up because one small piece had failed to stand the test, had certainly not taken place within the last twelve or fifteen years. The paper, as printed, was a very able one, and was of great importance to the whole trade, and he much regretted that in reading it Mr. Watherston had introduced matters of prejudice, to create impressions which had been contradicted over and over again.

Sir GEORGE BIRDWOOD said Mr. Thomas must not press on Mr. Watherston too much for any little rhetorical exaggerations into which he may have been betrayed. They were unavoidable in agitating against abuses. But Mr. Watherston had exaggerated nothing in his description of the treatment of the Indian silver service sent home by Messrs. Orr & Co., of Madras. It was as if the malice of the devil had been let loose upon the centre piece, so furiously was it torn and kicked about. He recollected, also, seeing the superb "cup" Mr. Watherston had spoken of, and how it had been ruined in the process of assay at Goldsmiths' hall.

Mr. PURDON CLARKE said he was in Madras in 1881, staying with Sir Mountstuart Grant Duff, and he then saw a quantity of plate which had been just returned from England, where it had been sent in good faith, carefully made under the superintendence of one of the partners of a firm in Madras, with the intention of being up to English standard, but it happened to be just a fraction below. This was of course discovered when it was sent to Goldsmiths' hall, and in consequence everything was first beaten flat, then doubled and hammered again, and in that state they were sent back. The owners were naturally very indignant, and it was proposed that these mutilated vessels should be sent first to the India-office, with the suggestion that they should be laid on the table of the House of Commons, to show the barbarous treatment to which Indian silver plate was subjected.

Mr. WATHERSTON, in reply, desired to thank Sir George Birdwood for what he had said as to his work in the past, though he did not quite agree with him on the question of Hall-marking. He must

point out, however, that he did not advocate the abolition of Hall-marking, he only wanted it to be voluntary, which would be quite as effective. He agreed with a great deal that Sir George Birdwood had said from an æsthetic point of view. The matter required very careful consideration at the hands of the Board of Trade, which he believed it would have. In reply to Mr. Thomas's objection, he regretted that he must repeat what he had said, and could give the exact particulars, and if it were required, he would insert these particular cases in the paper. One instance he might mention was that of silver plate belonging to Messrs. Orr, of Madras, which was completely destroyed at Goldsmiths' hall. He took it to the India-office, and showed it to Sir Louis Mallet and Sir George Birdwood, and he believed Mr. Martin Wood saw it also. Mr. Carlton Wood, Messrs. Orr's London representative, could also bear testimony to the fact.

The CHAIRMAN said he need not go in any detail into the merits of this extremely able paper, as they had been duly acknowledged by every speaker already, but they had also to thank Mr. Watherston for having initiated a very useful and interesting discussion. They had heard what had been already accomplished, and, as to the future, he need only say that his own sympathies were entirely on the side of greater freedom in all matters of trade. Nothing could be more mischievous on the whole than a system of compulsion and restriction, and he did not believe it was of any real advantage to the consumer. The best principle in such matters was that of *caveat emptor*. When they heard that the system of "touch" was so satisfactory in Europe, and even more so in India, they might feel confident that it would afford sufficient protection against any fraud which might be attempted. The struggle in the past had been severe, because so many personal interests were involved, but happily it had never been a party question. Both parties had, unfortunately, united in taking the same view of the necessity of protecting the British manufacturers against those of India. They were now in a more promising position, and the large increase which had taken place in the trade would encourage many who had hitherto imagined that their interests were going to suffer to take a wider view, and possibly to support Mr. Watherston in matters on which they had hitherto opposed him. He was sure they would all agree in wishing him success in his campaign, and in doing what they could to support him. He would conclude by proposing a cordial vote of thanks to him.

The vote of thanks was passed unanimously, and the proceedings terminated.

SIR THOMAS FARRER, Bart., in a letter to Mr. Watherston (dated from 27, Bryanstone-square, W.,

21st January, 1891), writes "to say that I am more satisfied than ever that the true remedy for the anomalies and difficulties of the present law is to abolish compulsory Hall-marking altogether."

APPLIED ART SECTION.

Tuesday, January 27th, 1891; Sir JAMES D. LINTON, P.R.I., in the chair.

The paper read was on "Lithography: a Finished Chapter of Illustrative Art," by WILLIAM SIMPSON, R.I., M.R.A.S.

The report of the meeting will be published in the next number of the *Journal*.

EIGHTH ORDINARY MEETING.

Wednesday, January 28th, 1891; LUKE FILDES, R.A., in the chair.

The following candidates were proposed for election as members of the Society:—

Butterworth, John Cyrus, 18, Finch-lane, E.C.
 Cannell, Henry, Swanley-junction, Kent.
 Clanwilliam, Earl of, K.C.B., K.C.M.G., 32, Belgrave-square, S.W.
 Evans, John Henry, Fairlight-villa, Elsworthy-road, Primrose-hill, N.W.
 Rankin, Charles, Stockton-road, Sunderland.
 Walker, J. M., Mancunium, Anerley, S.E.

The following candidates were balloted for, and duly elected members of the Society:—

Beaule, Clayton, care of William Joynson and Son, St. Mary Cray, Kent.
 Darley, James Jacob, 36, John-street, Bedford-row, W.C.
 De Woolfson, Lewis Estevan Green, 26, St. John's-hill, Shrewsbury.
 Earle, Hardman Arthur, 16, Victoria-street, S.W.
 Foster, Henry Llewellyn Thomas, Westminster Electric Supply Corporation, 32, Victoria-street, S.W.
 Hall, Charles Richard Guy, 13, St. Alban's-road, Kensington-court, W.
 Kloetgen, William John Hugo, 16, Watling-street, E.C.
 Lewis-Meredith, William, 7, Midland-road, Gloucester.
 Little, Henry, Baronshalt, East Twickenham.
 Lumley, Theodore, 37, Conduit-street, W.
 McKay, Andrew Davidson, 13, York-street, Liverpool.
 Mills, Major H. F., Junior United Service Club, S.W.
 Noble, Benjamin, Gloucester-house, Newcastle-on-Tyne.

Rhodes, J. H. H. Wentworth, 27, Park-square, Leeds.

Rivers, T. Francis, Sawbridgworth.

Sewell, Robert, Bellary, India.

Spoor, J. L., Stonecourt Cement Works, Greenhithe, Kent.

Stapley, Richard, Norfolk-house, Norfolk-street, Strand, W.C.

Thomas, John, Brook-house, Wooburn, Maidenhead.

Touch, George Alexander, 47, Goldhurst-terrace, South Hampstead, N.W., and Winchester-house, Old Broad-street, E.C.

Tyler, John William, Southwold-lodge, Cleveland-road, South Woodford, Essex.

The paper read was—

ILLUSTRATED JOURNALISM.

BY CARMICHAEL THOMAS.

The first difficulty a clergyman has to overcome in preaching a sermon is—so I have heard—to know where to leave off; and although this is not a sermon, you may perhaps think, before I have reached the end of the paper, that this peculiarity is not confined to clergymen. The first question is, "where to begin?" for the subject, "Illustrated Journalism," is such a vast one to tackle, that a very great number of papers would have to be written before the ground was fully covered. Allow me, then, to begin at the beginning, and to show you on the screen an illustration of the earliest known wood-engraving, St. Christopher; for although many different mechanical processes have been discovered, there is no doubt that engraving on wood has been the backbone of illustrated journalism, and that it really is so now, although no one knows whether it will continue to remain so in the future. The art of wood-engraving is supposed to have been practised in the 13th century, but nothing earlier has been found than this subject of St. Christopher, which is dated 1423, and is now in the possession of Earl Spencer. Illustrations gradually commenced to make their appearance in the newspapers of the 17th century, and as you may like to see a specimen of one which appeared in the *Mercurius Civicus*, in the year 1643, I place it before you. What King Charles I. said when it was placed before him I am unable to tell you. The portraits are intended for the King and his Queen, and the Lord Mayor, Isaac Pennington.

Time is too short for me to show many illustrations of those days, so I must simply state

that, slowly and gradually, editors of newspapers found out that a picture, occasionally inserted in the pages of their papers, brightened up the monotony of the columns, and at the same time gave the public a better idea of the subject matter than a lengthy description in words.

In the early part of this century, illustrations were not only appearing in the *Weekly Chronicle*, *Bell's Life in London*, and in the *Observer*, but loose sheets containing illustrations of important events were issued at irregular intervals, as occasion demanded, in the form of "broadside;" and you will now see a reproduction of one of these popular sheets on the screen before you.

The next picture on the screen is an illustration from the *Observer* of December 9th, 1827, representing a steam carriage invented by Mr. Gurney, which was tried experimentally in Regent's-park about that time. Although this engraving probably gave a very good idea of the invention, it is somewhat crude; and not only has pictorial illustration made great strides since then, but so also has steam locomotion—fortunately for us, if we may judge from an engraving which was published soon after, and which shows the result, or expected result, of this novel way of covering the ground. The "broadside" and the illustrations in the newspapers showed that the public would appreciate a regular illustrated paper, if such a thing were forthcoming; and it is to Mr. Ingram that the credit is due of starting the popular paper which, I am glad to say, is to-day in as healthy and prosperous condition as, no doubt, the present proprietors could wish to see it. Mr. Ingram, whose portrait is now on the screen, brought out the first number of the *Illustrated London News* in May, 1842—nearly fifty years ago. It has had a good many rivals, but the only really formidable one has been the *Graphic*; and I am quite ready to admit, on behalf of the latter paper, that the rivalry has done both papers a vast amount of good. Each has spurred the other on to produce better work, until, at last, between the one and the other, you have every event of any importance chronicled and depicted in their pages, whether it happen at home or at the other end of the world; and, in addition to this, the reproductions of works of art which are continually appearing in the illustrated papers have made known to everyone the pictures of not only the foremost artists of the day, but also of the Old Masters.

Before the days of the *Illustrated London*

News and the *Graphic*, if anyone wished to obtain possession of reproductions of the best pictures of the National Gallery, the Louvre, and other well-known collections, expensive prints had to be purchased; but nowadays, for a few pence, the contents of the art store-houses of the Continent are attainable and appreciated by people who have never been out of their own country.

Having thus briefly referred to the past history of illustrated journalism, I will, with your permission, show how a modern illustrated paper is produced; and to do so I must divide the process into three. I. Drawing. II. Engraving. III. Printing. We will trace the history of a subject such as you may see any Saturday in the *Graphic*, from the time when the event occurs, until you see it depicted in the paper. Let us suppose that a war is going on in Egypt, and that one of the special artists has made a sketch. I say one of the special artists, for if the campaign is an important one, it is necessary to have several, for skirmishes and battles may occur where they are least expected, and if everything of importance is to appear in the paper, one man cannot do it all. Here, now, is a specimen of the sort of sketches made by a special artist, this one being executed by Mr. C. E. Fripp. As soon as possible after the event has occurred, the sketch is placed (perhaps with others, perhaps by itself) in one of the red envelopes with which the artists are plentifully supplied, and sent off by the earliest mail. In due time it arrives in London, and within ten minutes of the mail bags being opened at the General Post-office, these bright and showy-looking packets are picked out by the officials, and by a much-appreciated command of the Postmaster-General, are handed direct to the representatives of the various newspapers, who are in waiting for them. If the envelope comes from Egypt, it will frequently arrive in London about 10 o'clock on a Sunday night, and half an hour afterwards the manager of the *Graphic* will be looking through the sketches, and deciding upon the sizes the drawings have to be made, and to which artists of the staff they are to be entrusted. By 11 o'clock messengers will be speeding on their way to different parts of the town as fast as the night horses of our London cabs will take them, that is if there is no delay; but very often a rough night in the Channel or a break down on the railway may keep the artists waiting half the night through, for those red envelopes may come from a greater

distance than Egypt. If trains are occasionally overdue when going from Charing-cross to Cannon-street, you can imagine that a sketch coming from Egypt, or perhaps Burma, does not always arrive when it is expected. There are occasionally other causes of delay, for I remember on one occasion an artist living at Hampstead who, tired of waiting for the subject he had to draw, took a quarter of an hour's stroll on the heath, and there found the *Graphic* messenger, with the sketch and block under his arm, having penny donkey rides. On the screen is shown a sketch received from Constantinople from a special artist, side by side with an impression of the drawing as it appeared when engraved and published in the *Graphic*. You will notice that it is altered in no respect beyond making it more intelligible to the public. The fact of its being reversed is due to a mistake of the photographer; but you will see just as well what I wish to indicate. This subject was redrawn on the wood by an artist of the London staff; but occasionally the special artist has the time to finish up his sketch in such a way that no re-drawing is necessary, as in the case of the next picture on the screen. When the subject has been drawn (or photographed direct) on to the wood, it is handed by the manager (after he has compared it with the sketch) to the head engraver, who divides the block up into pieces, and hands one portion to each engraver. This photographic slide represents a drawing on wood ready for the engraver, who will commence work as soon as the joins are finished; that is to say, the work must be commenced where the block divides, otherwise the pieces might not match. The back of the block is now shown, so that it may be seen how the different pieces are separated and screwed up again, by means of nuts and bolts. Now, before I take you into the engraving-room (Fig. 1), I must respectfully warn you not to ask two questions in the presence of the engravers. Certain it is that those questions will be asked by anyone who enters a studio for the first time, and, in order to avoid the half-smothered chuckle that will greet the inquiry, from all sides of the room, I will tell you that engraving is *not* considered trying for the eyes, as most people suppose; and if I mention that all engraved blocks are stored away for future reprints, if necessary, you will not ask, "Whatever do you do with all the old blocks?"

The engraver, as you can perhaps distinguish, has his block, or part of a block, before him, resting on a sandbag, which

enables him to turn it in any required direction. The globes on the centre table are used at night only, to concentrate the lamp light on the block; but you will see this better by looking at the next picture (Fig. 2), which represents the work being carried on during the evening, or perhaps during one of those cheerful winter days that we are so used to in foggy London.

When the block is engraved and screwed up, it is carefully looked over by the head engraver, who, if there is time, sends a proof to the artist for corrections. Sometimes the proof gives satisfaction and sometimes it does not. It is rather amusing sometimes to hear the artists talk of the engraving of their respective drawings. As an example of this I will relate how a short time ago an artist, whom I will call Mr. Jones, while complaining of the engraver, said, "Now if you would only engrave my drawings like you do Brown's I should be quite happy." Brown called the next day, and when I told him of this he replied, "Why, I consider Jones's drawings are improved by the engraving." I said nothing more, and having arranged that shortly afterwards both artists should call at the *Graphic* office at the same time. I started the topic; but I most bitterly regretted during the afternoon that I had not made the appointment on the Embankment instead of in my room in the Strand. This reproduction on the screen of a letter portrays the state of the artist's feelings, when he buys a copy of the *Graphic* and does not like the engraving. The artist does as a rule, I am glad to say, realise how difficult it is for the engraver to render his work in lines, and the more experienced the artist is, the less does he complain at the way his drawings have been reproduced. A small corner of the background may be engraved too dark, or a little piece of the foreground too light, and the general effect of the drawing may be somewhat altered by a careful and conscientious engraver, who sees his error when the proof is taken, and is quite ready to admit it. The small portion of the block which has been mis-interpreted by the engraver may be a bit which the artist has taken special pains to get right—a pet corner, in fact. The engraver's lot, like the policeman's, is not always a happy one, and in some cases—rare ones I admit—they must look upon the margin of a proof on which the corrections are made as a sort of barometer which indicates the state of the artist's liver.

I should like to show you that the impression of an engraving is very often so like the original

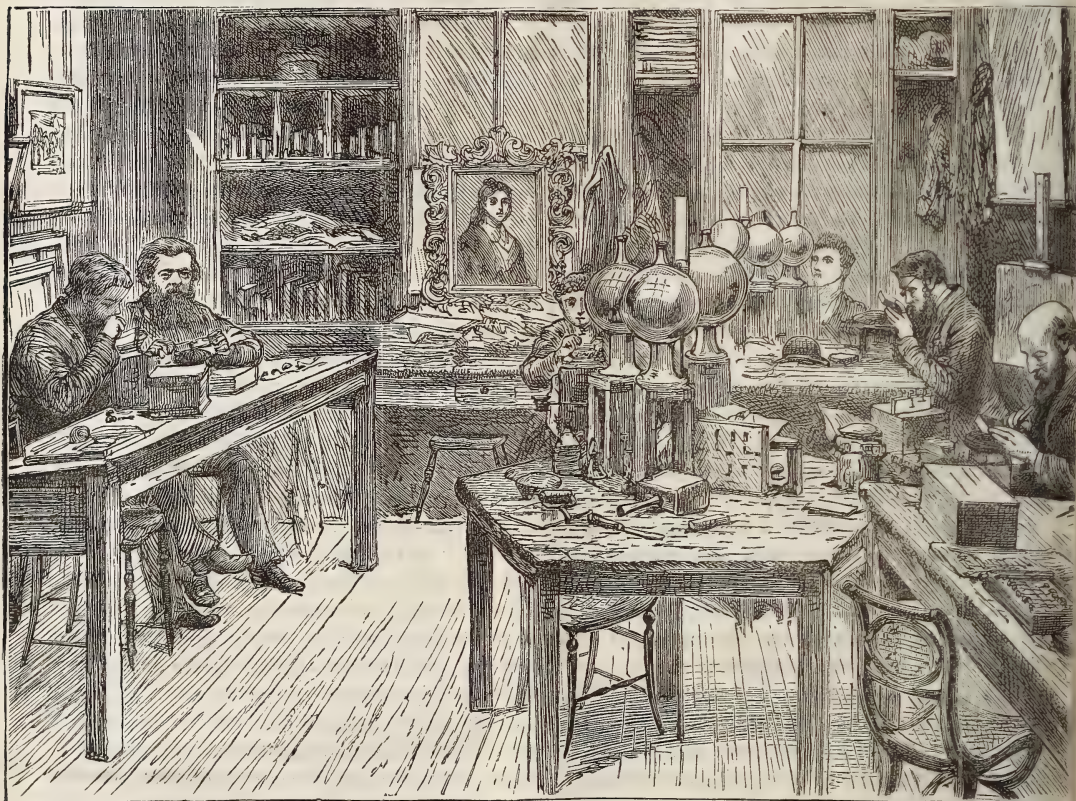
that one can hardly tell the difference between one and the other; but this analysis by the electric light is so searching, that I am afraid you will not quite see it. While you are comparing the impression of this subject with the original drawing, I should like to read a letter which came to the *Graphic*, when the illustration was published. It will give you some idea of the sort of letters with which the conductors of an illustrated newspaper are favoured.

"DEAR SIR,—In your issue of the 19th ultimo,

you published a drawing representing a convict's glimpse of the outer world, or something of the kind. Now this drawing has considerable likeness to me; and it is upon the inconvenience and annoyance (which has affected my health to a considerable extent, and is now, no doubt, standing in my way of getting further employment), that I have to ask that something is handed over to me, in reparation to health, and the defamation of character," &c., &c.

This subject is not drawn on the block in the same way as the one shown on the screen a few

FIG. 1.



THE ENGRAVING ROOM OF THE "GRAPHIC."

minutes ago. The drawing is made on paper, and photographed on to the wood, the advantages of this being that the artist can make his drawing any size he likes; and he can do it in Indian ink, pencil, or ordinary ink on paper, or even in oil colours on canvas. Then, again, the drawing is not destroyed, but can be compared with the proof, when the block is inked. This is a great boon to both artist and engraver. If a young artist asks my advice as to the best way in which his work should be done for the engravers (if the subject is to be on paper), I

always say, "Never mind the engraver; do the drawing as well as you can, and then the engravers will get a result as like your drawing as possible. Better devote your entire thought to getting your own work first-rate than to worry about other people's." On the other hand, if the drawing is done in wood, it has not the same freedom.

Now there are several ways of reproducing drawings for publication, for wood-engraving has many rivals nowadays, including some very successful ones. Here (on the screen) is

ing by the same artist as did the "Convict," reproduced by mechanical process. The impression is wonderfully like the original. For many reasons I am sorry to see the good old-fashioned wood-engraving being superseded by the many

mechanical processes which are being perfected; but I am quite sure that, in time, the really good wood-engravers, instead of finding their work leaving them, will find they are more and more sought after. The fourth-rate

FIG. 2.



THE "GRAPHIC" ENGRAVING ROOM AT NIGHT.

engraver no longer exists—he was at once ousted by process; then the third-rate engraver disappeared. The second-rate men are still having a fairly good time of it; but they must *look out*, for we do not know what further

developments are coming on in mechanical process work.

In the future, I believe, the first-rate engravers will be able to command almost any price for their work. For the last few years

there has been a mania for etchings; high prices have been paid and are being paid for etchings, simply because they are etchings, no matter whether good or indifferent; but the etchers too will be—no doubt are—feeling the change as well as the engravers. Photographic processes in the shape of photo-gravures, &c., are gradually pushing the second-rate etchings out of the market, just in the same way as the poorer class of wood-engravings are being superseded. I should not be at all surprised if, in a few years' time, a good wood-engraving is as much sought after as an etching is in the present day. The first-rate wood-engraver will make his fortune, while his second-rate fellow-worker will starve.

In America there is another startling change in illustrated journalism, for some of the papers there are not only giving up the wood-engravers, but they are giving up the artists as well. The illustrations are composed of photographs taken from nature or life, and reproduced direct by process without a touch from either artist or engraver. The manager of the paper, instead of asking an artist to illustrate a story, puts the manuscript in the hands of a photographer, and makes him do the work with his camera. Here, on the screen, is an illustration to a novel prepared in that way. In another case the manager wishes to illustrate the work being done by the Salvation Army in New York, and sends the photographer round with the reporter, instead of the artist. The result is most terribly monotonous and devoid of artistic treatment, but I think it is interesting here, as showing the latest development of illustrated journalism.

There is one advantage, however, in this form of illustration. It cannot well have doubt raised on its genuineness. If I were to show you a sketch in which the old lady who keeps the cows in St. James's-park was seen putting water into the milk cans, you might say it was made up; but when I place before you a photograph of such a proceeding, you must then admit, although all your better feelings are rudely shocked by the revelation, that it is true.

One more example I will put on the screen before I leave this part of my paper. In this case there is no artist's work; the photo from life was taken on board a P. and O. boat, sent to the *Graphic* office, where it was photographed direct on to the wood, and engraved.

But photography is useful, not so much as a means of doing away with the work of

artist and engraver, but of assisting them to get the details of their subject correct. Twenty years ago, during the Franco-German War and the Commune, the camera was a most important and valuable friend to the newspapers. When Paris was at the mercy of the lowest ruffians that the slums could produce, at the time when they were playing havoc with the buildings, monuments and streets, the photographers were hard at work, and the negatives they took give a true but dreadful picture of those terrible days. On the screen will be shown one or two specimens of what I refer to.

This shows the Rue Royale (Fig. 3) deserted and partly in ruins, taken during the last days of the Commune. The next is a scene on the Boulevards. The next shows the Rue de Rivoli; the damage to the houses is caused by shot and shell, not by fire. One can hardly believe that this bright and cheerful street could ever have been a scene of such utter desolation and misery as you see here. The next one (Fig. 4) depicts a barricade in the Rue Castiglione, taken from the Place Vendôme.

All these subjects appeared in the *Graphic* at the time, and show how important a part photography played, even as far back as twenty years ago. The next slide is a photograph of one of the meat tickets which was supplied to the *Graphic* agent (among others) during the siege. The ticket itself was far too valuable to be sent, so a photograph of it was taken and forwarded by balloon post. It was necessary to send two or three photographs by different balloons, or if sketches were used, to send tracings of them, for as likely as not the balloons would be captured by the Prussians, and whether they came down within reach of the enemy or not, the *Graphic* had to give its readers illustrations of all that was going on in the beleaguered city; and many manœuvres had to be executed to get the sketches and photographs outside Paris and through the Prussian lines to London. If anyone likes to look at the framed sketches on the walls after this paper is read, they will see some of the original sketches received at the *Graphic* office by balloon post about this time. That war produced some splendid subjects for illustration in the pages of the *Graphic*, and no doubt many here this evening will remember the spirited drawings of those young artists whose names are now household words with the English public. I refer to the work of our Chairman, Mr. Luke Fildes, Hubert Herkomer, Henry Woods, E. G. Gregory, Charles Green, Willis

FIG. 3.



THE RUE ROYALE, PARIS.
(From an instantaneous photograph taken during the Commune.)

FIG. 4.



A BARRICADE IN THE RUE CASTIGLIONE, PARIS.
(From an instantaneous photograph taken during the Commune.)

Small and others. But there was one consolation for them; in those days they certainly had enough to eat, at least I hope so, but the unfortunate agent of the *Graphic* who was in Paris during the siege, with his staff of sketchers and literary men, often longed for a good square meal. They had the work to do all the same, but it was done on a lunch of sardines, with a dinner of horse (if their purses allowed such a luxury) to follow. Any sort of meat was ruinously dear at that time; and even a good sized dog could not be bought under £8 or £10. This slide represents a cat and dog butcher's, prepared from one of the sketches received at the *Graphic* by balloon post. The day's dinner was not the only trouble; for anxiety of every sort was there as well. One day, during the time of the Commune, when the Versailles troops were hourly expected, the *Graphic* agent, Mr. Carter, noticed from the window of his house that a Communist, with a pair of horses fastened to a gun, had placed it in a small street exactly opposite where he lived, and, having unharnessed the horses, and arranged the ammunition ready for use, settled down for a comfortable rest. Seeing that the man was alone, Mr. Carter crossed the street, and inquired what was his object in choosing such a position. "Well," the man replied, "when the troops enter Paris, they will come down this street, and as they pass, I shall fire from the side, and certainly kill a dozen or more." "Yes, that's a good idea," said Mr. Carter, who trembled for the safety of his home and family; "but look here, why not place the gun at the end of the main street. Instead of firing from the side, and killing a dozen, you will fire at the front, and kill fifty." "Oui, mon ami, c'est vrai," and he thereupon harnessed his horses to the gun, and walked off.

It is a long time since there has been a big war like the Franco-German one; and although nothing (except a Royal wedding) pays the proprietors of illustrated newspapers so well, we hope that it will be many years before such terrible scenes of bloodshed occur again.

There are scenes, though, almost as sad, to be depicted even here in London. Scenes of misery and want. And I can give no better example of this than the first drawing which Mr. Fildes ever made for the *Graphic*. It was entitled "The Casuals," and appeared in the first number.

Illustrated journalism, by publishing scenes of battles and the sufferings they entail, may have done something towards preventing

people being too anxious to settle their international disputes by appeals to arms—and in times of peace it is not improbable that such drawings as the "Casuals" may stir up the better feelings of the more fortunate, and urge them to lend a helping hand to the miserable.

Now, to return to the drawing or subject which we were going to follow through to the time when it appeared in the paper. The block was engraved, screwed up, and all being satisfactory, the next thing is to hand it to the electrotyper.

As soon as the wood block is received, it is placed, face downwards, in a bed of wax, and, being put into a hydraulic press, a mould is obtained. This mould, after being coated with blacklead, to give it a conducting surface, is suspended in a large bath filled with a saturated solution of sulphate of copper, &c. Close to the mould is suspended (in the same bath) a plate of copper; and the effect of causing an electric current to traverse the system is to deposit a layer of metallic copper upon the mould, at the expense of the copper plate, which gradually dissolves. The thin shell of metal thus formed on the mould is, when it has attained sufficient substance, detached, and is filled up with metal, mounted on a block of wood to bring it to the same height as type, and is then ready for the printing machine. You will see on the table later on, if you wish to, a wood block, a wax mould, a shell—that is, the coating of copper deposited by the electrotype process—and, finally, the shell made ready for printing in the form of an electro. This process over, the printer takes the electrotype, places it on the machine in company with the type matter, and the result is, after printing, folding, inserting in cover and stitching, the *Graphic* as you see it on the Saturday.

Now I come to the *Daily Graphic*, the latest, and, I venture to say, not the least important development of illustrated journalism. For some years past the directors of the *Graphic* have had the idea of starting a daily illustrated paper, and a year ago the step of launching the enterprise was taken. Preparations were being made for several years before the first number appeared, for everything had to be arranged and tested to secure the efficiency of the different departments. A school of drawing was started, and the students were trained by a capable artist to do their work rapidly and effectively. Machine had to be made that would print illustration

FIG. 5.



THE FIRST NUMBER OF THE "DAILY GRAPHIC:"
ON THE PUBLISHING DAY.

at a high speed, for although there existed many that would print ordinary newspapers at the required speed, the difficulty was to find

those that could give the necessary brightness and clearness to the engravings. Eventually, two firms were selected, one English and one French, and here on the screen are representations of the two machines; the English coming first.

After many rehearsals, the first number of the *Daily Graphic* appeared, and there was such a demand for it that the machines could not turn out the quantities demanded by the newsagents, who broke in the doors of the publishing office in their eagerness to obtain the copies (Fig. 5). The difficulty of supplying them was increased by some of the machines going very wrong in those intricate parts which fold the paper after it is printed. This picture on the screen will give you some idea of what was taking place in the machine-room when the accident with the folders occurred. The result of these breakdowns was that thousands of copies went broadcast over the country in a more or less smeared condition. But this is now nearly all past history, for the printing is steadily improving, and all difficulties surmounted. Whatever may have been the difficulties in the printing department, the artistic and literary departments did not fail. There was some difficulty at first in getting the public to appreciate the fact, but it is nevertheless true that the *Daily Graphic*, besides being an illustrated paper, also contains the news of the day, and notwithstanding the initial difficulties,

FIG. 6.



THE "DAILY GRAPHIC" STUDIO.

no important item of news has been left out since the first number made its appearance.

This illustration (Fig. 6) shows the studio

where the drawings are made day by day. In this room the rough sketches, which are coming in at all hours, are re-drawn for the next morn-

ing's paper. Sometimes the sketches come by pigeon post, as you will see by this sketch of the arrival of a pigeon (Fig. 7). I must mention here that these feathered *employés* have been of great assistance to the *Daily Graphic*, and, with one exception, have done their work conscientiously. The only occasion on which it was necessary to find fault was on the boat-

race day, when one of the *Daily Graphic* birds was supposed to have been seen on a chimney-pot at Hammersmith, busily employed in picking off the sketch which was attached to his body. A great many sketches arrive from people in no way connected with the *Graphic*. When a number of porpoises appeared in the Thames, as many as twelve

FIG. 7.



THE "DAILY GRAPHIC" PIGEON POST: ARRIVAL OF PIGEONS.

sketches arrived during the day at the *Daily Graphic* office, the one chosen being now upon the screen (Fig. 8).

Not all of the sketches received are as good as the porpoise one, as you will see by a specimen now on the screen. Not even the most carefully trained artist could make an accurate reproduction of this scene, which represents Lord Napier's funeral. When the *Daily Graphic* was first started, some of the illus-

trations were drawn on wood and engraved; but the result was not satisfactory; and now they are all reproduced by a photographic process from drawings made on smooth white card with a very black ink. There have been published some very good illustrations done by people who have had no experience whatever in such rapid journalistic work as is necessary in the case of the *Daily Graphic*. Lady Butler has sent sketches from Egypt, done with

such a bold vigorous touch that they can be used as model drawings for the kind of work required. There is just enough work in her drawings, not too much to obscure the clearness, and yet quite enough everywhere to show exactly what she wishes to portray. I have not the time to mention more by name, but I dare say the signatures of many of the young artists who are working with such energy and ability will be already known to you.

FIG. 8.



PORPOISES IN THE THAMES: ONE OF TWELVE SKETCHES RECEIVED BY THE "DAILY GRAPHIC."

When the drawings are finished, they are handed to the manager of the photo-etching department, who prepares the plates for the printer. The camera by means of which the negative is taken is slung from the roof, so that the vibration of machinery, passing traffic, &c., may not spoil the result. The negative when taken is placed over a sheet of zinc which has been made sensitive to light, and this light (from an arc lamp) shining through the clear lines of the negative, acts upon the sensitive surface in such a way as to leave a record

upon the zinc. In short, by this operation the drawing is reproduced upon the zinc plate. Its lines are then made to resist the attack of the acid, and the plate put into an acid bath, where the non-protected parts are eaten away, leaving the drawing in relief—a surface which can be printed from.

These plates are then sent to the printing office, and having been mounted on metal, in order to make them the same level as the type, they are, with the type, arranged as required into complete pages. The next thing is to reproduce these pages into as many duplicates as may be required. Let us say ten—two for each machine. I told you how electros were taken of the wood blocks for the *Graphic*, and I will briefly describe how stereos are taken of the plates for the *Daily Graphic*. A mould is taken, not in wax, but in damp *papier maché*, by means of pressure; and as soon as the mould is lifted off the forme, and left for a few minutes to dry on a table heated by steam, it is taken to the casting machine.

The plates, when ready, must be curved, to suit the requirements of the printing machines, so the paper mould is placed here upon a curved bed, after which a cylindrical plate is brought against it, leaving a certain space, into which molten metal is poured. After allowing a few minutes for the metal to cool, the cylindrical plate is thrown back, and there is the paper mould, with the curved metal plate, which is an exact *fac-simile* of the original forme, composed of illustrations, plates, and type. After being trimmed up at the edges, the finished stereo is screwed down in the machine, and within a very few minutes each machine will be rattling off copies from the stereos at the rate of 10,000 an hour.

Before we go down into the machine-room, we will just take a peep into the editor's room, so that you may see the wonderful little machine that brings in the news by electric current, and prints it on a strip of paper which can be detached and sent straight away to the composing room, after the editor has seen it. The clerk who transmits the items of news from the office of the Exchange Telegraph offices to the evening papers depresses one of the keys of the instrument before him, and a letter corresponding to it is printed simultaneously in about 700 different buildings in London alone.

Having seen this little machine in the editor's room, we will not stay in there longer than necessary, for visitors are not much appreciated in such a sanctum. It is sad to

think of the many, many hours that are lost during the year by the editor or manager of a paper in seeing people who will not understand how valuable to him time is. There is the visitor who comes with a letter of introduction from some influential personage; he has got no sketches, but thinks of going to Timbuctoo, and would like to know if he should send sketches if he had time to make any. Then there is, among many others, the individual who brings a shocking bad drawing, and thinks if he talks long enough he can make you think it is good. We will leave the editor alone, then, and move on to the store-room where the paper is kept in rolls all ready for use. Here is one which was made for exhibition purposes, and is larger than those used by the *Daily Graphic* machines, but except that it is rather more bulky, the appearance is the same. The paper on this reel is $9\frac{1}{2}$ miles long.

Now we move on to the machine-room, but as you have already seen illustrations of the two different types of machines when I was referring to the starting of the *Daily Graphic*, we will only take a glimpse into the room.

When the five machines are all hard at work, fresh reels of paper being placed into position, the finished copies being transferred to the publishing office, and everything in full swing, there is such a scene of activity that it was necessary to take a view of the room during a quieter time of the day. The papers leave this department for the publishing office, and there is nothing more left to do than to get rid of them as quickly as possible. The paper is produced at tremendous expense, and then comes to the proprietors that most important part of the proceeding—the sale. The newspaper trains will be rushing through the country in all directions, and, as soon as possible, the papers are placed before the public.

We have followed a subject through—from the actual event to the time when you see it depicted in the paper; the description of each process has been brief, but I have tried to avoid giving too many technical details, for, in the first place, there would not have been time to have done so, and again, it might have been wearisome to many here this evening.

It gave me great pleasure to be asked to read a paper at the Society of Arts on a subject which, to me, becomes more and more interesting as my knowledge and experience extends, and it was a source of much gratification to me that Mr. Luke Fildes, who has

done so much for the *Graphic*, consented to take the chair; and it will be a still greater pleasure to me if I may believe that you have not regretted turning out of your comfortable homes on a winter's night to hear my paper on "Illustrated Journalism."

DISCUSSION.

Mr. HENRY BLACKBURN said it was many years since he first began to take an interest in this subject. In 1873 he was present in New York, when the first daily illustrated paper was published in New York, which was called the *Daily Graphic*, and was brought out by Canadians. Mr. Randolph Caldecott was one of its special correspondents. In March, 1875, he read a paper in that room on illustrated journalism, and ventured then to suggest that it was high time that a daily illustrated paper should be published in England. His excuse for suggesting so apparently extraordinary a thing was that they were then first able to produce blocks for printing by photography. They all had their own theories about illustrated journalism, but he could not withhold a tribute to the wonderful energies of Messrs. Thomas, and to the great success of the *Daily Graphic*. A journal which could produce such extraordinary likenesses of the members of the Royal Academy, who met between nine and ten o'clock at night, and on the next morning bring out a sketch of the proceedings at the election of members and associates, was a thing to be proud of; he would not pretend to say how it was done. They were all living in a very feverish state with regard to illustrations, and he would much prefer that a little longer time were taken over them. It was of course necessary to allow the event to happen first, but that was the utmost concession allowed. The *Daily Graphic* had overcome an immense number of difficulties, and had given a great amount of enjoyment. All those who could not see to read enjoyed their picture paper every morning, and, in a rudimentary state, they did get the news in the illustrations. He, however, had his own views on the subject, and had been waiting for many years, and was still waiting, for capital to carry them out. His idea was, that there should be a simple drawing, and a few lines at the top of each column, just to indicate what the writer was talking about. A short time ago he suggested to his friend, Mr. George Augustus Sala, what a nice thing it would be to have at the top of his letters from Rome a little sketch, indicating the kind of place he was writing from; but his reply was, what was the use of his devoting a lifetime to the art of pictorial writing, if it was to be all cut to pieces with two or three lines of a sketch. They had, therefore, first of all, to find capital; next to educate artists; and next to conciliate the journalists. Although the paper was very instructive and interesting, he ventured

to suggest that we were only at the beginning; and he would ask such gentlemen as Mr. Thomas and others to go on and develop still further the art of illustrating in a few lines the events of the day.

Mr. JOHN LEIGHTON, F.S.A., said this graphic account of illustrated journalism was a sequel to his friend Mason Jackson's work upon the same subject. Illustrated journalism might be said to have first taken form in the year 1832 with the *Penny Magazine*. It seemed but yesterday that he bought the first number of the *Illustrated London News* for fivepence, with a picture of a State costume ball at Buckingham Palace, by John Gilbert. This was the precursor of pictorial papers all over the world. Mr. Ingram encountered many rivals, some of which he bought out of the field, until the *Graphic* appeared, and with it the Franco-Prussian War. As peace and the Great International Exhibition of 1851 consolidated the *News*, so war made its rival, the *Graphic*. This newspaper had been remarkable for its illustrations, the work of the engraver on wood. The weekly *Graphic* having proved a great success, the enterprise was followed by a diurnal; and as the great weekly had depended upon wood-cuts, it was quite natural that the babe should do the same, though, since then, wood has given place to "process," greatly to its benefit. Process blocks depended wholly upon the artist, without any intervention or translation whatever, and he ventured to suggest that the weekly should continue to depend upon wood, whilst the daily should confine itself to process blocks—wood and fine printing being made for "colour," whilst process was rapid, both in production and impression. Black and white would always be the backbone of illustrated journalism. Mr. Thomas had made but one mention of coloured pictorial art, though it now played a great part, and here, again, Herbert Ingram was the pioneer; and he held in his hand the first coloured effort, which paved the way for Sant's "Little Red Riding Hood," of which several sets of blocks were worn out, and "The North-West Passage," by Millais.

Mr. W. LASCELLES SCOTT exhibited some specimens of a new method of colour printing, invented by his friend, Colonel Muter, in which, instead of using a large number of stones or blocks, any number of colours could be produced at one impression, and the method therefore seemed well adapted for book-illustration. The block was built up of the different colours, the thickness depending on the number required, and it was gradually printed away. The specimens exhibited were not very artistic, but showed what could be done.

The CHAIRMAN, in proposing a vote of thanks to Mr. Thomas, said England might well feel proud of having produced two such papers as the *Illustrated*

London News and the *Graphic*, and the objects their proprietors had in view would quite meet the criticisms of both Mr. Leighton and Mr. Blackburn; they were desirous of carrying out to the fullest extent all that it was possible to do to make them perfect. Although Mr. Thomas had said that the *Graphic* had been much indebted to him (the Chairman) in the past, he had always felt that the obligation was the other way, for it was in connection with the *Graphic* that he and many other artists first became known to the public. He had reason to believe that the founding of the *Illustrated London News* and the *Graphic*, and the admirable way in which they had encouraged the best art of this country, had been a very great help indeed to the profession; and one could not but regret that no such papers existed in the time of Hogarth, the first great illustrator, and, in fact, the father of all illustrators. Illustrated literature was a purely national product, of which England might well be proud. She had not only led the way, but had produced the finest illustrated publications ever seen. And many men who were now famous, owed their individuality and success to their early training on illustrated papers.

The vote of thanks having been passed,

Mr. THOMAS, in reply, said the principal point in Mr. Blackburn's remarks was that the *Daily Graphic* ought to do better, and no one felt that more than himself. They were always trying to improve it, and he thought they had improved it a great deal already. Mr. Leighton advised them to keep woodcuts out of it—which they certainly should do, because they could not print them—and to keep "process" out of the *Graphic*. No one was a better judge of how a picture should be reproduced than the artist, and very often he preferred "process" to wood-engraving. They endeavoured to use whichever was most suitable; if they thought a drawing would come out well in wood, they employed it, and so with process. With regard to Mr. Lascelles Scott's specimens, these things all depended on the printing; he had often seen very beautiful proofs, but if large numbers had to be printed they came out quite different. In conclusion, he desired to express his sense of obligation to Mr. Hepworth, who had been kind enough to read his paper for him.

Miscellaneous.

THE FORESTS OF HUNGARY.

The Belgium Consul-General at Buda Pesth reports that the forests of Hungary have an area of 9,200,000 hectares (hectare is equivalent to 2·47 acres), of which

about one-fifth is inaccessible, by reason of the absence of ways of communication. Of these 9,200,000 hectares, the State owns about 1,500,000; the remainder belongs to public bodies and to private individuals. There are 2,600,000 hectares under oaks; 3,400,000 hectares under red beech; 1,900,000 hectares under resinous trees; and 800,000 hectares under elms. The remainder consists of birches, poplars, maples, ash willow, alder, &c. The Hungarian Government does not sell any part of its forests; on the contrary, it purchases more each year. The price for forests of red beeches varies between 30 and 600 francs per hectare, according to their position. In certain parts of the country, particularly in the eastern region of the Carpathians, woods are found several thousand acres in extent, almost exclusively of red beech; but this is an almost valueless wood. It is but little used, except for carriages and agricultural implements. It is, however, specially used in the manufacture of bent wood; and it is also made into staves for cheap casks; but it is principally used for firewood. In places where means of transport are available, merchants purchase the timber as it stands. In Slavonia, where the best oak forests of the monarchy are to be found, the price for the right of cutting the trees—leaving to the vendor the ownership of the soil—is 4,000 francs per hectare. As regards resinous trees, it is chiefly in Transylvania that there are large forests of these, but they are not very accessible, and the price ranges from 30 to 100 francs per hectare. In the north-east of the country, in the district of Marmaros, they are also largely found. There are few fires, and even when they do occur, it is only on the ground, and it is stated no cases have been known where the trees have suffered from the ravages of fire. The taxes on forests vary between 8 centimes and 2.50 francs per hectare. In exceptional cases they reach 3.75 francs for woods of great value. The tax goes to the benefit of the State. There are also taxes levied for the benefit of public bodies; these vary from 2 to 50 per cent. of the principal tax. The revenue from the forests but little exceeds $3\frac{1}{2}$ per cent. of the capital sunk; often, however, it is only $2\frac{1}{2}$ per cent. Certain districts, provided with navigable streams, as the banks of the Theiss towards its source (north-east), of the Waag and of the Gran (north and north-west), of the Samos (east), and of the Maros (Transylvania), have forests which are very cheap, and which can give a regular yield for the annual sales. It is in Slavonia that the forests appear to have the best future, notwithstanding their very high price. Oak of the best quality is to be found there. For resinous trees, it is the Marmaros which rule the market. The growth in the value of the forests worked in Slavonia has, in recent years, been about 10 per cent. annually. For resinous woods it has been about 5 per cent. As regards red beech wood, which is used chiefly for fuel, its value is diminishing, owing to the competition of coal. In the districts of

the north and east, the Belgian Consul says that there are vast forests still unworked, which would only cost 30 to 35 francs per hectare, and which will acquire a certain value when the ways of communication permit of their working. Their purchase would constitute an investment for the future, but it is difficult to foresee when the profits will come. Those who had effected a purchase of this kind in Slavonia, thirty or forty years ago, would, it is said, have tripled or quadrupled their capital. Owners of forests who reserve their right of sport, must indemnify their neighbours for the damage done by the game. The Crown domains at Godollo pay, under this head, about 12,000 francs annually, and other large properties pay as much as 16,000 or 17,000 francs.

CULTIVATION OF HEMP IN SMYRNA.

In cultivating hemp in Smyrna, the United States Consul there says, that from one and a half to two bushels of seed are sown per acre. The fibre is long and tough, and of good yellow tinge; but, owing to the crude process of shedding, its good qualities are nearly ruined. The price of seed varies between two shillings and threepence and two shillings and sevenpence a bushel; and it generally contains from twelve to fifteen per cent. of extraneous matter, chiefly sand. The height that the hemp usually grows is from six to seven feet and a half; in some cases so high, in fact, that Consul Emmet says a man can ride through his fields on horseback without being seen. Hemp is cultivated in almost every village or hamlet of Asia Minor, where an abundance of running water is to be found. The hemp fields are cultivated as near the water as possible, owing to the moisture required while growing, and the use made of the stream after the seed is gathered. The ground is lightly ploughed, and sown broadcast with from one and a half to two bushels of seed per acre. It is then gone over with a heavily-weighted plank, drawn by oxen, to break the furrows and cover the seed. Nothing more is done to it. If the season be advantageous, and the water supply does not fail, by the receding of the stream, the yield will be good. The crop is cut and put in bundles, when the stalks turn yellow. The seed is gathered, and the sheaves of stalks are immersed in the stream near by, for the purpose of rotting the shell or reed containing the hemp fibre. When the cultivator thinks it sufficiently softened, the bundles are taken from the water, opened, and subjected to a heavy pounding with large mallets. After this, the fibre is extracted by hand, and put in shape for selling. Owing to the process of softening the stalks, or perhaps leaving them too long under water, the fibre darkens and partly rots when exposed to the air, which renders it unfit for foreign markets. It is consumed in the manufacture of coarse bagging and rope, for use in

the interior. The hemp seed grown in Smyrna, and exported abroad, is of good quality, and is exported mainly to Germany, Austria, Holland, and the United States, for the extraction of oil. It is also used, to some extent, by the natives as an article of food. The seed is pounded in mortars, and made into a paste, and then fried. The Jews are particularly fond of it, and value it. The principal places in the vilayet of Smyrna where hemp and hemp seed are obtained are Odemish, Thyras, Mazli, and Homak Cairch.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

FEBRUARY 4.—J. EMERSON DOWSON, "Decimal Coinage, Weights, and Measures." SIR HENRY E. ROSCOE, M.P., F.R.S., will preside.

FEBRUARY 11.—SIR ROGER LETHBRIDGE, M.P., "The Proposed Irish Channel Tunnel." The DUKE OF ABERCORN, C.B., Vice-President, will preside.

FEBRUARY 18.—COL. SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S. "Methods and Processes of the Ordnance Survey." The ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

FEBRUARY 25.—E. J. RAVENSTEIN, "Colonisation and its Limitations." Sir RAWSON RAWSON, K.C.M.G., will preside.

MARCH 4.—J. HARRISON CARTER, "Modern Flour Milling."

Papers for which no dates have as yet been fixed:—

"The Sources of Petroleum." By WM. TOPLEY, F.R.S.

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"The Use of Petroleum in Prime Motors." By WILLIAM ROBINSON.

"Electricity in relation to the Human Body." By H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D.

"Harbours, Natural and Artificial." By F. H. CHEESEWRIGHT.

"The Durability of Pictures Painted with Oils and Varnishes." By A. P. LAURIE.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock:—

FEBRUARY 17.—COMMANDER V. LOVETT CAMERON, C.B., "Chartered Companies in Africa."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Papers for which dates are not yet fixed:—

C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

LEWIS ATKINSON, "The Diamond Fields of South Africa."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

FEBRUARY 26.—ROBERT GORDON, M.Inst.C.E., "The Economic Development of Siam." SIR CHARLES EDWARD BERNARD, K.C.S.I., will preside.

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. the LORD REAY, G.C.S.I., G.C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 10.—HEYWOOD SUMNER, "Sgraffito." CHARLES BARRY, F.R.I.B.A., will preside.

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

POPULAR AFTERNOON LECTURES.

Friday afternoons, at half-past 4 o'clock:— Captain ABNEY, C.B., D.C.L., F.R.S., "The Science of Colour."

February 13, 20, 27; March 6, 13.

CANTOR LECTURES.

The following Course of Cantor Lectures will be delivered on Monday evenings at Eight o'clock:—

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

LECTURE II.—FEB. 2.—Wind Instruments—Recent date of modern orchestra—Improvements of Wind Instruments in the present century—The Wood Wind: Flute, Oboe, Bassoon, Clarinet—Characteristic tone quality not due to material employed—Boehm's Flute—Seventeenth century family of Recorders—The Oboe and Bassoon Reed—Its antiquity—Difference of cylindrical and conical tubes—Seventeenth century family of Oboes—The Oboe di Caccia, Oboe d'Amore, Cor Anglais—The Sarru-

sophones—Seventeenth century family of Cromornes—The Bagpipes; Syrian Scale—The Clarinet, acoustic peculiarity—The Clarinet Reed—The Bass Horn and Bass Clarinet—The Saxophones—The French Horn—Valves or Ventils—The Trumpets and Trombones—Bach's Trumpet parts—Seventeenth century family of Cornets or Zincken—The Serpent, Basson Russe, Ophicleide—The Tubas and Saxhorns—Euphonium—Bombardon—Contrabass—Cause of modern rise in pitch.

LECTURE III.—FEB. 9.—Instruments grouped by the adaptation of a Keyboard—Its service to composition—History of the Keyboard—The early Organ—The Drone—Drawings of early portable Organ Keyboards—The Cantigas de Santa Maria—Keyboards in Italian and Flemish paintings—Summary of early large Church Organs from Praetorius—The long measure bass—The short measure or short octave—The mixture—Its dissection into registers—The pedal Keyboard—Sketch of a complete Organ—The Regal—The Harmonium and American Organ—The Echiquier and the precursors of the Piano—The Pianoforte.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 2 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. J. Hipkins, F.S.A., "The Construction and Capabilities of Musical Instruments." (Lecture II.)
 Royal Institution, Albemarle-street, W., 5 p.m.
 General Monthly Meeting.
 Engineers, Westminster Town-hall, S.W., 7½ p.m.
 Inaugural Address by the President, Mr. W. W. Colam.
 Chemical Industry (London Section), Burlington-house, 8 p.m. Mr. W. C. Young, "Standard Sperm Candles."
 Surveyors, 12, Great George-street, S.W., 8 p.m.
 Discussion on Professor J. Wrightson's paper, "The Basis of the Cost of Wheat-growing."
 British Architects, 9, Conduit-street, W., 8 p.m.
 Baron Henry de Geymüller, "The School of Bramante, and its Expansion throughout Italy and the rest of Europe."
 Medical, 11, Chandos-street, W., 8½ p.m.
 Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m.
 W. Boscawen, "Recent Results of Babylonian Archaeology."
 London Institution, Finsbury-circus, E.C., 5 p.m.
 Mr. Whitworth Wallace, "Pompeii, the City of the Dead." (Illustrated.)
 North-East Coast Institution of Engineers and Shipbuilders, Hall of the Literary and Philosophical Society, Newcastle-upon-Tyne, 7½ p.m. 1. Discussion on Mr. Hök's paper, "The Unsinkability of Cargo-carrying Vessels." 2. Discussion on Mr. M. Sandison's paper, "Main Steam Pipes." 3. Mr. A. Blechynden, "The Influence of the Relative Dimensions and Proportions of the Screw Propeller on the Vessel's Performance."

TUESDAY, FEB. 3 ... Royal Institution, Albemarle-street, W., 5 p.m. Prof. V. Horsley, "The Structure and Functions of the Nervous System." (Lecture III.) "The Spinal Cord and Ganglia."
 Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.
 Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Pathological, 20, Hanover-square, W., 8½ p.m.
 Sanitary Institute, 14A, Margaret-street, W., 8 p.m.
 Mr. H. Law, "Principles of Calculating Areas, Cubic Space, &c.; Interpretation of Plans and Sections to Scale."
 Biblical Archaeology, 9, Conduit-street, W., 8 p.m.
 Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. R. W. Shufeldt, "The Question of Saurognathism of the Pici, and other Osteological Notes upon that Group." 2. Count D. Salvadori, "Two New Species of Parrots of the Genus *Platyercus*." 3. Mr. P. L. Sclater, "A Collection of Birds from Tarapacá, Northern Chili."

WEDNESDAY, FEB. 4 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. Emerson Dowson, "Decimal Coinage, Weights, and Measures."
 Geological, Burlington-house, W., 8 p.m.
 Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. Frederick Enock, "The Life History of the Hessian Fly." 2. Mr. Roland Irimen, "Some Recent Additions to the List of South African Butterflies." 3. Mr. Henry W. Bates, "Additions to the Carabideous Fauna of Mexico, with Remarks on species previously recorded." 4. Mr. William F. Kirby, "Notes on the genus *Xanthospilopteryx*, Wallgr." 5. Dr. David Sharp, "The Rhyncophorous Coleoptera of Japan." (Part II.)
 Archaeological Association, 32, Sackville-street, W., 8 p.m.
 Obstetrical, 20, Hanover-square, W., 8 p.m.
 Civil and Mechanical Engineers, Westminster Palace Hotel, S.W., 7 p.m. Mr. H. Daniell, "The Jerome Steamship Shaft."

THURSDAY, FEB. 5 ... Royal, Burlington-house, W., 4½ p.m.
 Antiquaries, Burlington-house, W., 8½ p.m.
 Linnean, Burlington-house, W., 8 p.m. 1. Mr. J. Gammie, "The Tree Ferns of Sikkim." 2. Mr. A. Barclay, "Life History of Two Species of *Puccinia*."
 Chemical, Burlington-house, W., 8 p.m.
 London Institution, Finsbury-circus, E.C., 6 p.m.
 Mr. George Massee, "Plant Tendencies towards Animal Mode of Life."
 Royal Institution, Albemarle-street, W., 3 p.m.
 Mr. Hall Caine, "The Little Manx Nation." (Lecture IV.)
 Archaeological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

FRIDAY, FEB. 6 ... United Service Inst., Whitehall-yard, 3 p.m.
 Mr. C. R. Markham, "The Advantage of forming Collections at Greenwich, with a view of supplementing the means of studying the Origin and Gradual Development of various Branches of Naval Science."
 Royal Institution, Albemarle-street, W., 8 p.m.
 Weekly Meeting, 9 p.m. Lord Rayleigh, "Some Applications of Photography."
 Geologist's Association, University College, W.C., 7½ p.m. Annual Meeting.
 Philological, University College, W.C., 8 p.m. A Dictionary Evening, by the President, Mr. Henry Bradley.
 Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.
 Sanitary Institute, 74A, Margaret-street, W., 8 p.m.
 Dr. Louis Parkes, "Water Supply, Drinking Water, Pollution of Water."

SAURDAY, FEB. 7 ... Metropolitan Board Teachers' Association (at the House of the Society of Arts), 3 p.m.
 Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.
 Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Martin Conway, "Pre-Greek School of Art." (Lecture III.)

Journal of the Society of Arts.

No. 1,994. Vol. XXXIX

FRIDAY, FEBRUARY 6, 1891

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the course on "The Construction and Capabilities of Musical Instruments," by Mr. A. J. HIPKINS, F.S.A., was delivered on Monday evening, 2nd inst.

Mr. Henry Carte and Mr. D. J. Blaikley played upon the various wind instruments which were described in the lectures. Instruments were lent by Messrs. Rudall, Carte and Co., Messrs. Boosey and Co., and Messrs. John Broadwood and Sons.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, January 27th, 1891; Sir JAMES D. LINTON, P.R.I., in the chair.

The paper read was—

LITHOGRAPHY: A FINISHED CHAPTER IN THE HISTORY OF ILLUSTRATIVE ART.

By WILLIAM SIMPSON, R.I., M.R.A.S.

It may be fitting to mention at the commencement of this paper that for a good many years, in the early part of my life, I was a practical lithographer; and that there are few of the processes connected with the

lithographic art but what I could turn my hands to. This will assure those who hear me that, when I deal with the technique of the subject, I am not speaking at second-hand, but am treating that with which I chance to be perfectly familiar.

To avoid any misunderstanding, it may be as well to point out that the words "Finished Chapter" do not apply to lithography beyond the position it once held of being one of the principal means of book illustration. It will only be my purpose to show how in this position, which it held for many years, it was superseded by other art processes. Lithography is still largely used, and is well adapted for many purposes. It is a beautiful art, and has many capabilities, regarding which I may have something to say before I have done with this paper.

Lithography was discovered, or invented, or both, by Johann Aloys Senefelder. The first thing was what might be considered a very small discovery; but on this slight basis a large number of methods were invented by the originator. I have always understood that Senefelder had practised all the various processes which have since been employed, and more or less developed them while he lived. The life of the inventor shows that he was a very able man, and this explains how he so developed and perfected the art which he discovered. He never was rich; he may be said to have died poor. Not that he wanted chances—he had many, but he never succeeded in business, for his mind always turned to working out new ideas, and the practical part of his affairs were overlooked. He is described as having been a dirty, untidy man, with much uncombed hair; and that he never was so happy as when absorbed working out some new part of his process. He was not a disappointed inventor, like so many others; the merits of his discovery were recognised while he lived, and he received gold medals and other honours, as well as money at times. The Society of Arts awarded him a gold medal in 1819.* The King of Bavaria was a great friend of Senefelder's, and gave him a pension, by means of which the latter part of his life was made honourable and happy. He died in Munich. Often we have heard of people who declared that the name of some object they

* This Society also granted a premium of £20 to Jos. Netherclit, for his method of making lithographic transfers. This shows that the Society of Arts has, from a very early date, taken a great interest in the art of lithography.

have devoted their lives to would be found engraved on their hearts. When Senefelder died, it might be said that lithography had marked itself on his brain. A *post-mortem* showed that there had been a growth upon that organ—in this case, a very rare disease. Within an integument were two small stones, each of them about the size of a hazel nut; the Germans call them *fenensteine*. Senefelder suffered very much from headaches, and this growth is supposed to have been the cause. These stones were deposited, and are now preserved, in the Polytechnic Society at Munich.

The inventor of lithography was born at Prague, in the year 1771, and died in 1834. His father had been an actor, and Senefelder imbibed in his youth an ambition for the stage. The active mind of the man, at this early period, also led him to try his hand as a dramatic author; and it was to his efforts at success in this walk that we owe the discovery of printing from stone. He failed as an actor, and fell back on dramatic writing; but the difficulty was to find the means of publishing what he wrote. He was too poor to do it in the ordinary way; and here the life of the man as a discoverer and an inventor began. If he had been able to purchase the ordinary type, lithography might still have been undiscovered. He attempted first, by means of a paste, in which clay was the principal material, on which he stamped letters and words, to produce a species of stereotype plate.* Not being able to produce practical results in this way, he took to a process of etching on copper; but copper was expensive, so he tried pewter; but etching on this turned out to be a difficult task. There was a particular kind of stone in the district which went by the name of Kehlheim stone; it was also known as Solenhofen stone, which could be procured cheap, in the form of thin slabs. This is the material now known as lithographic stone. It is a limestone, very porous and absorbent, and yet capable of taking a fine polish. The first efforts with these were similar to etching on a plate; that is, he laid on a ground, scratched through it with a point, and then bit it with acid. This produced an engraving on stone, which had to be printed like copper-plate. From 1791 to 1796

Senefelder seems to have been working at this process, and all the time in the greatest poverty. This was stone-printing, but it was not that which was afterwards known as lithography. When he was afterwards asked how he discovered the right process, he used to say that it was in writing out the account for his laundress. This took place in 1796. Some clothes were being given out to wash, when Senefelder's mother asked him to make a list of the articles. No paper chanced to be at hand, so he took one of the polished stones that was lying ready, and made the necessary note on it, with the etching ground he had been using.

As few are familiar with the process of lithographic printing, it may be as well here just to describe it in a broad way, so that the discovery made by the above incident may be understood. The process is often affirmed in books to be chemical. This is to distinguish it from the purely mechanical operation in type and copper-plate printing. So far as I understand, I doubt if there is really anything chemical in lithography. When water is absorbed by a sponge, we cannot say that chemical action has taken place; neither can I see that it occurs when a stone absorbs water or grease. My chemistry is of the slightest, so this is not given as authoritative. If the surface of a lithographic stone is polished—and it takes on a polish like marble—then anything that may be written or drawn upon it with a greasy ink is absorbed into the stone. The remaining surface is then covered with gum water, to which is added some nitric acid; the gum being also absorbed, prevents any further grease from adhering, and the stone is ready to print. The printer's roller is covered with ink. If it was rolled over the stone without being damped, the whole stone would receive the ink, but if the stone has been damped, the writing or drawing, being greasy, throws off the water, and the ink from the roller only goes on the work; not a particle of it is received by the wet portion of the stone. The damping and rolling in has to be gone through for every impression.

The whole principle of lithographic printing, it will be seen, depends on this of the greasy ink rejecting the water from the surface, and thus receiving the ink from a roller passed over the stone. In ink, chalk, and colour-work there is no other principle brought into action. Like the egg of Columbus, and many other things, it seems very simple—when we know it; but Senefelder did not catch it quite

* The glyptographic process, which was invented a good many years ago, although it failed to supersede wood engraving, was, so far, a successful method, and might be looked upon as the realisation of this first effort of Senefelder's.

at first from the bill of his laundress, for the first idea which it suggested to him was to etch the stone with acid, so as to have the writing on the bill in relief, and thus be able to print it something like type, but the success of such a method must have been far from hopeful. It chanced that in his etching ground soap was one of the ingredients, which is still used in the making of lithographic ink, and the grease in this at last put Senefelder on the right path. Here was the germ discovered, from which the whole art of lithography has sprung. This was the discovery on which the inventor began to work. He had many difficulties in his way, including his poverty. A proper press to print the new process was one of these, for neither the type nor the copper-plate press are at all adapted for the stone. At last he triumphed so far over them that he was able to show results, and among the first applications of the new art was the printing of music.

It is unnecessary in this paper to follow the history of Senefelder; this hasty sketch of the man and his invention forms an instructive introduction to the subject, giving the dates which are of importance in following out its progress. The slight details of the lithographic process will now enable me to explain how it was that it took the place of engraving as a means of illustration. Many may yet remember how books used often to have on their title pages, "Embellished with numerous copper-plate engravings." Woodcuts were not then quite unknown, but books of any pretensions were illustrated with engravings on copper. As soon as lithography was established, and had been practised long enough so that good work could be produced—that means when both artists and printers had progressed sufficiently—lithography very soon superseded engraving. For commercial work the trade of a copper-plate printer almost entirely ceased to exist. This result was owing to the comparative speed of the printing. In taking an impression from a copper-plate, the whole surface of the plate has to be daubed over with ink, so as to force the ink into the engraved lines; the ink on the surface of the plate has then to be rubbed off, and the plate carefully wiped, and finally the printer uses the soft part of the palm of his hand, on which he has some white chalk, to remove the least chance of stain from ink or oil. All this takes a long time. The lithographic printer has only to damp his stone with a sponge or cloth, pass the roller over a few times, and he is ready to

throw off the impression. I forget now the comparative numbers the copperplate and lithographic printers could each produce. The lithographer might be able to print perhaps about three or four impressions, or more, for one of the other; and by means of transfers, by which a number of the same pieces of work can be put on the one stone, the difference in speed of producing can be largely increased. A fine drawing on stone requires more care in printing than commercial work, but so does a fine engraving; and here again the speed in printing is quite as marked as in the other case. It was this speed, and consequent cheapness in the printing, particularly where large numbers were required, that gave lithography the advantage, and led to its extensive adoption for book illustrations.

It was not till the process known as "chalk work" had been developed, that lithography was capable of taking its place in art illustration. In this department of the art, instead of ink, crayons with grease in them had to be used; and instead of a polished stone, a very fine granulation had to be given to the surface. To those who begin to work with this material the softness of the crayon is a difficulty, but this is easily got over, and it is then found that very beautiful work can be done with it. The most delicate and atmospheric effects can be produced, as well as force, with touch and texture in the foreground. It is well adapted for landscapes, as well as for figure subjects; very beautiful portraits can be drawn on stone; architecture, shipping, in fact, every class of subject are within the range of its capabilities. At first, in landscape, the sky had to be tinted in with the chalk, and this was slow work, requiring great delicacy and patience; but ultimately the sky was produced by means of a tint done on another stone, which implies a second printing; this tint also gave the higher lights in the foreground. This style simplified the artist's work, and although it added a printing, it did not stand in the way of the style maintaining its position, for after it came into use all landscape work was done in this manner. If you find an old lithograph with the sky tinted with the crayon, it will tell you that it belongs to an early period of the art, and its date might be given roughly as coming within a certain number of years. At a later time two tints became a favourite style, one was a buff or brown, and the other a grey or blue, which produced the sky.* This gives us

* Roberts's "Holy Land," a large folio work in four volumes, containing 250 plates, was lithographed by Loui

the first steps which were made towards chromo-lithography, about which I shall say something farther on.

It will now be necessary to give a slight sketch of the progress lithography made, in order to show the results it obtained, and the position it occupied in connection with illustrative art. I shall begin first with France. The French Revolution and the wars of Napoleon naturally interfered by obstructing almost all in lustry and progress. This was the period when lithography appeared, and in its early years it had to struggle against this as well as other difficulties. At first the French Government were opposed to it, because Napoleon feared that it would give great facilities for counterfeiting paper money. It is stated that Senefelder started an office in Paris as early as 1802, but if this was the case, he left it next year and went to Vienna. André, of Offenbach, was connected with this first attempt. In 1818, Senefelder had an office in the Rue Servandoni, where he produced a French translation of his work on lithography.* The Count de Lasteyrie has the credit of having first successfully established lithography in Paris. He, with Godefroy Engelmann, went to Munich and learned the new process. It was in 1815 that Lasteyrie, with Engelmann, began in Paris. At first, the encouragement was not great, but slowly it rose into favour. One cause which helped the new art was that many eminent artists eventually took to its practice. One of the early ideas was that the crayon should not be twice passed over the same spot on the stone. Fragonard did his work in this way, and there are specimens of it in Baron Taylor's book. Villeneuve was one of the first to change this practice, which led, of course, to a style of higher finish. These were landscape artists. Later on, figure painters tried their hand on stone, and were much pleased with it as a

manner of working. Carl Vernet, the painter, and his more celebrated son, Horace Vernet, have both produced many works on stone. Isabey, the miniature painter to Napoleon I., Gericault, the Baron Atthalin, who was brother-in-law to Louis Philippe, have all done good work in lithography, as well as Mauzaisse, Dubufe, Aubry Lecomte, and Marin Lavignec. Grévedon did some beautiful portraits by the new process; and Charlet produced civil and military caricatures, which were in considerable demand at the time. Daguerre, who invented the Daguerreotype, was an artist, and Bouton, who, with Daguerre, invented the diorama, both practised lithography. Bonington, another artist of celebrity, who, although an Englishman, resided at that period in Paris, has left specimens of his powers at drawing on stone. The work of most of these artists may be found in the large work by Baron Taylor, called "*Voyages Pittoresques et Romantiques dans l'ancienne France*." Taylor was himself an artist of some repute, and had the title of Baron conferred on him by Louis Philippe. Baron Taylor's book is in itself almost a history of lithographic illustration; it is large folio, and extends to something like twenty volumes, the first of which appeared as early as 1820; and the publication went on for nearly half a century. The early style in which the art was practised will be found in the first volumes; and its progress may be traced down through the period in which lithography was so largely employed for illustrative purposes. The mode of working by Fragonard may be seen, as well as each new process which appeared as the art progressed. Taylor did not limit himself to French artists, but employed men of ability wherever he could find them; amongst English artists will be found the work of Haghe, Harding, Barnard,* Gale, and others.

The art received a great impulse in France from an artist, Aubri le Comte, who developed its capacity for power as well as high finish, so that it might be applied to the reproduction of works of high art. He lithographed the "*Danaë*," and other subjects of importance in the Louvre. His greatest work was the reproduction of Girodet's grand picture of the "*Deluge*," and the quality of this artistic production may be assumed from the high

Haghe; the first half of this book was done in one tint, but in the later parts of it two were employed, and at the end there is one plate, "*The Simoon in the Desert*," in which there are three tints. This work thus becomes a sort of guide to the period of the progressive step towards colour, and may be put, roughly, as representing the "forties," while the tinting of the sky with the crayon might be given as in the earlier part of the "thirties." Another work lithographed by Louis Haghe was Lord Monson's views of the Valley of Izère, a large folio volume with a considerable number of plates; these were produced before the "tint" period; and were all done on the one stone with the crayon.

* "*L'Art de la Lithographie*," dated 1819. In the same year an English edition came out, with the title of "*A Complete Course of Lithography*," published by Rudolph Ackermann. The German title was "*Vollst. Lehrbuch der Stein-druckerey*." This appeared in 1818.

* Mr. Barnard died only last year. He was for many years Drawing Master at Rugby School, of which he did a series of drawings in lithography. These were published in a volume, which forms one of the best illustrated books of that school.

price he was paid for putting it on stone, which was 10,000 francs, or over £400. It was printed by Lemercier, but, unfortunately, the stone broke,* and only a very few impressions were taken.

We have one evidence that lithography in Paris must have been looked upon as a great success, after its merits had been appreciated and become established. This is found in a "Chanson de Vaudeville," of which I chance to have a copy, but, unluckily, I do not know its date. Amongst the uses to which lithography had been applied at this early period was calico printing, or at least pocket handkerchiefs had been illustrated by its means, as the *chanson* indicates.†

That lithography had thus become the subject of a song sung in the theatres, is evidence that it must have enjoyed at the time an almost exceptional popularity. The reference to the "arm of a cossack," or the "leg of a Prussian"

* This is an accident to which lithography was always unfortunately liable. I believe that at a later period the chances of this were reduced to nearly nil by the practice of backing the stone with a slate slab when being printed.

† Calico printing by means of the stone was one of the original ideas which Senefelder entertained. I know that numerous attempts were made in this direction. Evidently, from the *chanson*, it had been tried in France; and trials were made in Glasgow, where calico printing is an important trade. There is no difficulty in printing on cloth from the stone; but the printing ink is not a "fast colour"—it is boiled oil, ground with the same colours, which artists use. This will not combine with the cloth, but only lies on the surface, and soon washes away. In Glasgow, at one time, lithography was largely used for printing the patterns on sewed muslin. This was only to guide the sewers. The pattern, if any of it was visible after the sewing, was bleached out. In the "forties" and "fifties," this sewed muslin trade was a very large one in Glasgow and a large number of people were employed designing and lithographing the designs.

VIVE LA LITHOGRAPHIE !

"C'est une rage partout ;

Grand, petit ; laide, jolie ;

Le crayon retrace tout.

Nos boulevards tout du long,

Aujourd'hui font un salon,

Où, sans même avoir posé.

Chacun se trouve exposé.

On tapisse les murailles,

De soldats et de hauts-faits ;

Et l'on ne voit que batailles,

Depuis que l'on a la paix.

Nos mouchoirs de poche aussi

Ont leurs combats, Dieu Merci !

Grâce à cette nouveauté,

Une sensible beauté

Peut, quand l'amour l'accable,

Essuyer ses yeux fort bien

Avec le bras d'un Cossaque,

Où la jambe d'un Prussien !

Nos paravents, nos écrans,

Sont couverts de combattants ;

Jusqu'au fond du compotiers,

Où voit placés des guerriers."

on a pocket handkerchief, wiping away the tears from a beauty's eye, tells that this song must have been sung shortly after the war, when the doings of Prussians and Cossacks were still fresh in the minds of every one. The warriors on the jam-pots would seem to show another application of the art, and that it had been utilised in pottery.

A very noted instance of the application of lithography for illustrative purposes in Paris was that of the *Charivari*. For a long series of years its principal cartoon was produced in "chalk" on stone, and the principal contri- butor to this Paris "Punch" was the celebrated Gavarni. His bold dashing style, full of character, was most effective, and his subjects were all evidently knocked off in a hurry, but the printing of such a publication must always have been too rapid to do justice to the artist's work. I have seen more highly-finished lithographs by Gavarni, which were very beautiful.

It was nearly about the same period, when the Comte de Lasteyrie was introducing lithography in France, that Jobard was doing the same in Belgium. One of the artists employed by him was J. B. Madou, who produced, by means of the new art, a series of "Views in the Netherlands," which is now a very scarce book. This gentleman became a noted artist and an honorary president of the Société des Aquarellists in Brussels, and an honorary member of the Society of Painters in Water Colours* in London. De Wasmé first started in Tournay, and then removed to Brussels about five or six years after Jobard had begun, and his establishment soon eclipsed the older one. Among the artists connected with him were P. Lauters, Madou, Fourmois, Billoin, and Vanderhart. De Wasmé published a number of works, amongst which may be mentioned "La Physiognomie de la Société en Europe, depuis l'an 1400, jusqu'à nos jours," published in 1837. He also established a school for wood engraving, which was directed by an engraver from England named Brown. The Belgian Government was anxious that this art should be cultivated, and a grant of money was given by the Government to carry it on.

There is some uncertainty about the introduction of lithography to London. One statement is that Senefelder himself came to London with André, of Offenbach; another is that André started an office in 1802, and left it in charge of his brother, through whose in-

* Now the Royal Institute of Painters in Water Colours.

capacity it failed. Another effort, it is said, was made by two Germans, in 1807, and that also was a failure. Engelmann, who has been already mentioned in connection with the establishment of lithography in Paris along with the Comte de Lasteyrie, also opened places in Mulhouse, Vienna, Berlin, St. Petersburg, and Madrid; to these he added another in London in 1811. All I know about this attempt is that the Messrs. Hanhart are reputed to be the lineal descendants of it. Ten years after this the art might be said to have become firmly planted in London, and by that time it had also begun to be practised in various parts of the country.

The man who had, perhaps, the most to do in this country with lithography, in connection with art illustration, was my old friend Louis Haghe. He came to London in 1823, and practised at drawing on stone till about 1851, when he devoted himself exclusively to water-colour painting, in which he held one of the foremost places, being the President of the Royal Institute of Painters in Water Colours. I always considered him to be about the first lithographic artist, not only in this country, but in Europe. He was born in Tournay, in the south of Belgium.* An officer of Napoleon's army, named Le Chevalier de la Barriere, being thrown out of commission after 1815, had picked up some knowledge of lithography in Paris, and being exiled, he came to Tournay, where he managed to procure a second-hand press from Jobard, and began to do work with it. It was in association with this simple establishment that Mr. Haghe made his first acquaintance with lithography. A landscape painter, named M. J. B. De Jonghe, had commenced a series of drawings entitled "*Vues Pittoresques de la Belgique*," in which Mr. Haghe assisted; De la Barriere returned to France, but De Jonghe and Haghe continued and finished the views in Belgium. Some progress must have been made in Tournay, for a young man named Maxwell had been attracted there from England to study lithography. De la Barriere having left, Mr. Haghe gave him instruction, and was induced to return with him to London. The hopes that induced this move were not at first realised, but perseverance, and Haghe's undoubted ability at last succeeded. Subsequently, Mr. Haghe, became acquainted with William Day, the original founder of the firm known later as Day and Son. It is generally under-

stood that it was the great artistic talent of Mr. Haghe that created the name which that firm enjoyed; for some years the establishment was known as that of Day and Haghe.*

Here I shall give a short list of the more important works that passed through Mr. Haghe's hand. Lord Monson's work, already mentioned, was an early one; Vivian's "*Spanish Scenery*;" Vivian's "*Spain and Portugal*;" "*Views and Sketches in Afghanistan*," from sketches by Dr. Atkinson, a work illustrating the first Afghan War. He was also engaged with others in the reproduction of Muller's "*Age of Francis I.*;" of Roberts's "*Spanish Sketches*;" Stanfield's "*Views on the Moselle*;" Roberts's "*Holy Land, Egypt, and Nubia*;" Haghe was nine years engaged on this large work. One of his last performances was a series of drawings of Santa Sophia, Constantinople. And about the same time he did, on stone, a large subject, "*The Destruction of Jerusalem*," by David Roberts. This was, perhaps, the largest highly-finished lithograph that was done in this country; the work covered on stone a space $42\frac{1}{2}$ inches by $27\frac{1}{2}$ inches. I saw this subject before a printer's roller had touched it, and my opinion is that it was the most elaborate and perfect piece of lithography that had been anywhere produced. Unfortunately, it was rather under-etched, and the impressions, even the earliest of them, failed to convey any just idea of the real merit of the work. In addition to these, he did a large quantity of other work—single plates, illustrations for books, &c.—and I have seen very elaborate portraits done by him in his early days.

There is another artist whose name is worthy of mention, that is J. D. Harding. His work was principally that of books for teaching art. One of his earliest was "*Sketches at Home and Abroad*;" these were done with one tint. "*The Use of the Black-lead Pencil*," and "*The Park and the Forest*" were important works as lessons in trees. He also produced a good many drawing-books. Lithography has a special advantage in such subjects, for the picture to be copied by the learner in this case was the actual touch of the master; and Harding had a fine,

* Mr. Haghe, I have been told, only gave his name to the firm, but he had no monetary interest in it. He only received the money for the work he did as an artist, but I think he had the first choice of any work coming to the place. It ought here to be mentioned that Mr. Haghe had only one hand, the left one. The right hand was defective from his birth, being almost without fingers.

* Born 17th March, 1806. Died at Stockwell-green, Brixton, 9th March, 1885.

bold, free touch with the crayon. Harding, at times, illustrated books—"Scotland Delineated" may be mentioned as one in which he did a good many of the plates. I think that the firm of Hullmandel and Walton were generally his printers.

I may here add the names of a few of the artists who have done good work in lithography, most of whom I have known personally. Andrew Picken was a good landscape lithographer, but he died early of consumption; his brother Thomas has wrought long in the same line.* George Hawkins did architectural subjects, and was principally employed by architects lithographing new and important buildings. Lynch did most beautiful portraits. Richard James Lane also did portraits and picture subjects, and was made an Associate of the Royal Academy—being the only lithographer who received this honour.† Baugniet also did portraits; he drew them direct on stone from the sitters; this artist was a Belgian, and he returned to his own country and became a noted painter in oil of *genre* subjects. J. A. Vinter also did portraits. I have a book with lithographic views, and the name "S. B. Pyne" is given; these are artistic, but do not show much experience of lithography. Gauci was a landscape artist. Robert Carrick has done a variety of good work, but left lithography for water-colour painting. Mr. Walton did landscape work. T. G. Dutton was a shipping artist, and has done a large amount of work in this line. Edmund Walker was engaged in a variety of subjects, and produced many of the views of the great Exhibition of 1851. Ed. Morin, a French artist, was in this country a few years, and also produced a good many subjects connected with the great Exhibition; on his return to Paris he was on the staff of the *Journal Illustré*. J. Needham was a pupil of Harding's, and was a good landscape artist. A few of these artists are still living, and among those who still find employment, I ought to mention the names of Mr. George McCulloch and Mr. Jones. The

late Andrew Maclure, of Maclure, Macdonald and Macgregor, should also be noted as a man of versatile talent.

The slight sketch of the beginning and development of lithography here given has been made up from such fragmentary materials as I chance to have within reach.* Without pretending to anything like completeness as a historical notice, it may still be sufficient to serve the purpose intended, which is to give a rough notion of the period when the art grew and achieved its position as a means of illustrating books, as well as the events of the time, and thus its chronological relationship will be followed.

What will now follow is that which has come more under my own knowledge, and will deal with lithography as it existed in 1851—the year I came to London. I might say that, at that time, it was in the full zenith of its career as an illustrative art. If a traveller, on his return home, published a book, the illustrations were lithographed. Had there been a war in India or the Cape, and some one brought home sketches, they were published in a volume of lithography. 1851 was the year of the first great Exhibition, and the illustrations of it were nearly all lithographs. A number of very large ones were done, and an immense quantity of them were printed. More than one artist painted pictures of the opening ceremony, and three or four of these, at least, were reproduced in large lithographs. Many smaller prints of the different courts were also done. I was kept so busy at that time with work of this kind connected with the Exhibition, that I could scarcely get a day to myself to go and see it. The *Illustrated London News* was started in 1842, and had been then nine years in existence, but had not absorbed—as it and other illustrated papers have since done—the all but exclusive function of giving pictures of passing events. If we had a similar exhibition in the present day, I doubt if a single lithograph of it would be published. The illustrated papers would give large views in the shape of supplements. Every court and object of interest would appear in these journals, while photographs of all sizes and prices would be sold. You have only to con-

* Since this paper was written, I have learned that Mr. Picken is no more. He died in the Charterhouse, of which he had for some years been one of the brethren. This took place on the 23rd ultimo.

† He received this honour under the character of an "Associate Engraver," lithography seemingly being classed under this title in the Royal Academy. Lane's work principally consisted of portraits, those I have seen done by him being very fine and delicately touched. I remember a full-length figure of one of the principal *danseuses* of the times—Taglioni, if I recollect right, which Lane did on stone. He was brother to Edward Wm. Lane, the well-known Arabic scholar, and author of "Lane's Modern Egyptians."

* Some further details will be found in articles written by myself, which appeared in *The Lithographer*, afterwards called *The Printing Times and Lithographer*. One was "A Contribution to the History of Lithography: Introduction of the Art into France and Belgium," Feb., 1874; "Our Contemporaries: Louis Haghe," Oct., 1877; "The Early History of Lithography: Glasgow Reminiscences," Jan. 1879.

trast what would take place at the present date with what I have told you of the Exhibition of 1851, to realise the change that has now taken place. It is this great and marked change which justifies the words, "a finished chapter," which I have applied to lithography as an illustrative art.

Let me give another example. Books of travel, scientific expeditions, and almost all illustrated books had their illustrations done in lithography. Now they are all produced by wood engraving. If a lithograph appears in books of the kind at present, it is a rare phenomena. It may be explained that the wood-cut has a similar advantage over the lithograph that the lithograph has over the copper-plate, that is, a greater rapidity of printing. Or, to put it in another way, it may be said that, as the wood-cut can be printed with the letterpress, it entirely did away with the separate printing. This is, of course, a most important matter when a large number has to be produced. This condition will in itself explain the change which has taken place in this particular branch.

In the case of wars—of which we had a number of little ones, in India and Africa, which took place at various times—these were generally illustrated by a volume of lithographs. If any officer made sketches, he was able to find a publisher for them after the war was over. The first Afghan war was illustrated in this way from sketches made by Dr. Atkinson. One of the wars at the Cape was also done in the same way. My own sketches of the Crimean War were lithographed and published in two folio volumes. This was one of the last examples of this style of illustrating military events.* Any officer bringing home sketches at the present date from any war would find it utterly impossible to find a publisher. Special artists would be on the spot during the events, and the sketches would appear in the illustrated papers at the moment. In this branch, where lithography had for a time almost an exclusive position, the change is as complete and perfect as need be. Again it is a finished chapter.

Important public events were the subject of lithographic prints. As an example, when the Duke of Wellington died I did a lithograph of the funeral car; I also put on stone

the lying-in-state at Chelsea Hospital, and the scene during the funeral in St. Paul's Cathedral. Such subjects belong now entirely to the domain of the illustrated journals.

Important public buildings and new churches, if they had any claim to architectural pretensions, passed through the lithographer's hands. I am entitled to speak on this particular branch from having put a good many drawings of this description on stone. Now these appear in the architectural journals, such as the *Builder* and the *Architect*. When the building is up, should there be a demand, photographs are made of it.

At the period I refer to, new clipper ships, new steamers and men-of-war, were almost all lithographed. One artist, Mr. T. G. Dutton, was for many years constantly employed on work of this kind. I am not quite sure how subjects of this kind are now done; I suppose photographs supply whatever demand there may be.

Lithography had almost an exclusive position for a long time in portraits. Popular members of Parliament, actors, singers, dancers, clergymen, and all celebrated persons, had their portraits done on stone. It need scarcely be stated that the photographers have the whole of this work in their hands now.

I could go on and give other details of the same character,* but these examples should be sufficient to show the change which has taken place. Illustrative work is still produced from stone, but the amount is limited, at least, the more artistic class of production is small. What is done is principally show bills or posters. I understand that some firms can produce large sheets for this class of work, and some of these are very effective, and in some instances they are not without claims to artistic merit. If the newer modes of illustrative art had not come into competition, lithography would have still been a flourishing branch, and with the extended demand for illustrations of the present day, a large number of artists would have been required. Lithographic artists were not, as a rule, mere copyists; they had to be artists, for they had generally to turn rough

* If I mistake not, a volume was afterwards published, with lithographs from sketches made by Colonel Dodgson, of some of the spots connected with the fighting at Lucknow during the Indian Mutiny.

* For instance, there was a good deal of lithographic work done in illustrating scientific works; and in connection with this there are two names that are worthy of mention. Mr. Erxleben was long employed in lithographing bones for Sir Richard Owen. Some of Mr. Erxleben's drawings of this class of subject on stone were really works of art. The other was Mr. Fitch, who did illustrations of botany for the late Sir William Hooker, and also for his son, Sir Joseph Hooker. I have long been familiar with Fitch's work, and can speak of its great artistic merit.

sketches into pictures; the result was that most of them practised painting, and there was a tendency among them to become painters, of which numerous examples could be given. We have the same tendency now among the draughtsmen on wood, a number of whom have already become eminent in the artistic world.

I feel that I ought to say something about chromo-lithography, and yet I find it somewhat difficult to do so. The development that led to it had begun when I was at work on the stone, but it was after I had ceased to lithograph that "chromos" became a sort of fashion, and large numbers of them appeared. They tell me now that there is still work of that kind going on—a large amount of it is in Christmas cards—but the more artistic efforts are of a limited kind. In Germany there would appear to be somewhere a large manufactory of chromos, in which very commonplace pictures are very mechanically reproduced. What has caused the limitation of chromos in this country is rather beyond my knowledge. At one time good work was done, but, as a rule, the subjects chosen were mostly of the bright, showy kind—the sort that would sell under the idea that they would light up the walls and have a pleasant effect in a drawing-room. This rather uniform style became so common that at last the art critics found it to be a damaging sentence to say that a picture was "like a chromo-lithograph." This style of talk may have had a damaging effect on the chromos at the same time. I am inclined to believe that many of the men who wrought at chromo-lithography were little more than copyists; the difficulty was to find persons of artistic knowledge and capacity to undertake such work; one result of this was that a very large number of printings was the rule, because the artists groped their way in the dark, and added stone upon stone to produce the effects required. I have heard of chromos which had between twenty and thirty printings on them, thus making them very costly articles to the publishers; this costly extravagance I attributed almost wholly to the want of knowledge on the part of the artists. I am supported in this from the fact that my friend, Mr. Robert Carrick, produced one of the finest chromos that has yet appeared. The subject was the "Blue Lights," a very beautiful oil picture by Turner, full of most delicate tints, and at the same time a work of great power and effect. Mr. Carrick reproduced this picture with only

twelve stones.* If artists such as he was could have been induced to work at this particular art, I feel sure that the term "chromo-lithograph" would never have been used in the sense it now has of damaging reproach.

Lithography has so many methods, giving capabilities for variety of effect, that if experienced artists could be prevailed upon to take it up, I believe much could be done in the way of reproducing almost any style of picture. Etching is now fashionable, but equally good effects can be produced on stone by means of tints. As a lithographer, I would say that it would be more satisfactory to an artist to do his work on stone instead of scratching through an etching ground with a needle. At least, that is my feeling on the subject. In working on stone you see what you are doing, which is not the case with the etcher. Much time would also be saved by lithography. It must take considerable work to go over a sky with the needle; this, when done with a tint, can be accomplished in a very short space of time, by merely rubbing some greasy ink over the stone with a bit of rag. With a drawing stone, and say with two tints—I do not mean the old buff and blue tints, but tints that would produce a monochrome, either black or brown, as etchings are now printed—any effect could be produced that is now done in etching; depth, power, and delicacy could be given by this means. This manner of working would be, I consider, more satisfactory to an artist than etching; it would be easier and quicker. Here, I believe, is a field for lithography in which work could be done; all that is wanted is that regular trained artists should take it up. I feel certain that, if artists were familiar with what can be effected in lithography, they would not be bothered with etching. In expressing this, I fear that few will accept my view of the case. But I can say it is no new idea with me, nor is it an opinion that I hold alone. I have asked more than one of the lithographic men who have become painters, whether they would etch or work on stone, and the answer has always been in accordance with my own notions. It may, perhaps, be thought these persons are naturally favourable to their own branch, but I do not think so. They all know something of etching as well as of lithography, and could thus judge, so far, of the merits of both. Artists to whom I have spoken on this matter, and who, of course, reject the pretensions of lithography, are, unfortunately, all but

* There were very few copies of this work printed, so it was but little known.

ignorant of the capabilities of what they will not accept. The lithographers' opinion has knowledge behind it, which that of the others has not. I would say to the artists, let them try the stone, and I have no doubt of the result. They will like it, and find that they can by its means produce prints that will be their own work, in touch, and in all other qualities that belong to art. If artists could be induced to do what is here suggested, it is possible that there might be a revival of lithography, and a new sphere of activity would return. This would only be for pictures or prints to hang on our walls, not for illustrations for books and other purposes, dealt with already in this paper—that is a thing of the past. I have spoken of monochromes, in imitation of etchings; but in lithography an artist need not be limited to monochrome. A tint or two of slight colour might be added, or a good deal of colour could be given. And all that is wanted is, that artists are required to do the work; and if they would only try, they would find that from a monochrome to a highly-coloured subject can be produced; and they would find that works could be done which need not have the slightest resemblance to a "chromo-lithograph."

I have ventured on these expressions of opinion on chromo-lithography and etching at the end of this paper. They must stand for what they are worth. The main purpose of the paper was what might be called the rise and fall of lithography as an illustrative art. It has a practical moral. As lithography has become a finished chapter, so the various methods which are now in vogue may become the same. Wood engravers are already complaining of what is called "process;" that their work is not so plentiful now as it used to be, on account of these late inventions. You will find that books of travel, as well as others, are now published, in which photographs have been converted into blocks, and thus printed without the aid of either the wood draughtsman or the wood engraver. It will also be noticed that "process" blocks from "pen and ink" subjects, as well as from photographs, are becoming more and more frequent in the illustrated papers. It is rather difficult to speak with precision as to what may be the final result, but it is just possible that as lithography cut out engraving on copper-plate, and wood engraving superseded lithography, so wood engraving may also find a rival in "process," and its history and fate as a "finished chapter in illustrative art" may

have to be written before many years have passed.

Volumes of David Roberts's "Holy Land," Simpson's "Crimean War," all illustrated with lithographs, and David Roberts's *Destruction of Jerusalem*, by Louis Haghe, were exhibited by Mr. Simpson. Turner's "Blue Lights," by Carrick, and Sir John Gilbert's "Spanish Peasants," by Risdon, were kindly lent by Messrs. Vincent Brooks, Day & Son.

DISCUSSION.

Mr. HUGH STANNUS said he had listened with the greatest pleasure to this most interesting paper, from one who had the best claim to be considered a practical exponent of the art. The splendid book of his sketches in the East showed how thorough a master of the art he was. The paragraph in which, having mourned over the decay of lithography as a method of book illustration, Mr. Simpson had pointed out that the same fate might overtake the system which had superseded it, viz., wood-engraving, might perhaps be prophetic; and perhaps he had some satisfaction in thinking a Nemesis might overtake those arts which had caused the decay of that one in which he himself was most interested. He had referred to Bagniet as drawing portraits direct on the stone, and no doubt that would produce fine results in the hands of an able man. The sky-tint produced by means of a second stone was a great aid in lithographic effects; and David Roberts' great book was a magnificent example of what could be done with tints. He might add that the same method had been adopted in wood-engraving, a very fine example of which was the set from Andrea Mantegna's "Triumph of Julius Caesar," by Andrea Andreani, executed in 1599, in which there was first an outline on wood, and secondly a tint, in which the high lights were cut out, a good broad effect being thus produced without hatching. If artists would take up lithography, sky effects would be very easily produced by a second tint. Another fine illustrated book, which had not been mentioned, was "The Dresden Gallery," published many years ago; and at that time it could only have been produced in lithography. Every artist who had been to Paris knew the magnificent work in the Church of St. Vincent de Paul by the French artist Flandrin; and every one must be grateful to him for having put them on stone, the greater part with his own hand, in the monograph published shortly after. Another fine example was the roll on the table, representing the pediment of St. George's-hall, Liverpool, which was drawn by Alfred Stevens. The water-colour was at South Kensington, and he afterwards put it on stone. This was a magnificent example of the power of an English artist, and showed what a command he had over the processes of lithography. And the result

was encouraging to other artists to essay autographic work in lithography.

Mr. F. VINCENT BROOKS said he had listened with a great deal of pleasure to the paper, but, at the same time, as an enthusiastic lithographer, and the son of one, he must say he joined issue as to lithography being a closed chapter, and it gave no signs of being so. At the present time there were ten times as many engaged in it as there were twenty years ago. One trade operated upon another, and lithography was, to some extent, dependent on cabinet-making. Of late, the drawing-room table had been reduced in size, until it hardly existed, and, as a result, the books which used to be designed for it were no longer required. In place of them, however, there were the delightful little miniature books which came out at certain periods of the year, and sold almost by millions, and which did a great deal in disseminating art amongst the people. He could not help seeing that lithography was not very much in vogue at the present time; it might not be thought very much of in Bond-street; but still there was a much good work being done; they simply had to change their methods, and supply what the public demanded. He was sorry that the production of important subjects in chromo lithography had, to a certain extent, passed away, but there was nothing final in the present state of affairs. A great revival had taken place in etching and mezzotint engraving, and the same might take place with lithography. They were day by day introducing new methods which made the process more simple, changing their ground to suit the requirements of the time, and it was a little hard to be told that they were only flogging a dead horse. He was glad to agree entirely with Mr. Simpson in the hope he expressed that artists themselves would take up lithography. The revivals he had already alluded to were due to the fact that artists had seen the wisdom of becoming their own interpreters. In lithography one difficulty was the ponderous character of the medium employed, but there were people in this and other countries devoting themselves to the task of making the medium more portable, and he was pleased to be able to say that Mr. Wezel, of Leipsic, had succeeded, and very soon the lithographer would be able to work with a medium as portable as a copper-plate. When that was done, they would very probably get that support from artists which they did not receive at the present time. Two names which had not been mentioned in connection with the art were Mr. Risdon and Mr. William Bunny, who were still living, and were well worthy of record.

Mr. LEWIS DAY said all he had done in connection with lithography was to design for it. *Apropos* of the idea that there should be what he might call painter-lithographers as there were painter-etchers, he said that in France there were men doing that kind of thing. A short time ago a professor of art

in one of the American Universities, who had been in Europe collecting engravings, etchings, and the like for the use of his class, had shown him some proofs of very fine original lithographs, which were sold in France much as etchings were sold here, only at a much lower price. The difficulty which occurred to him was what the publishers might say to it, if English artists were to take up lithography in that way. The artist might find himself unable to dispose of his work when it was done. He would like to know what Mr. Simpson thought about photolithography; certainly that was not a finished chapter; it was just beginning. Unfortunately, the results as yet of many of the photolithographic processes were not very satisfactory; but only a lithographer could say whether their defects were insuperable. With regard to the application of lithography to pottery, it had been practised for many years, but never, to his mind, satisfactorily, probably because sufficient colour could not be got on to the ware to allow for its "firing out" in the kiln. Anyhow, the effect of painted tiles and the like was granular and poor.

Mr. E. A. WÜNSCH, as a countryman of Senefelder, had been much gratified with the paper. He could not say much as to the artistic side of the question, but he knew how largely it had been employed commercially, as, for instance, in Glasgow for the decoration of handkerchiefs. The first instance he remembered was at the time the Emperor Maximilian went to Mexico, when large quantities of handkerchiefs with his portrait were sent out there. After the German War the same idea was carried out in Germany, but the Germans did not take to it, and a large quantity of handkerchiefs had to be shipped to Africa, where the negroes bought them readily. Whenever any one became prominent, their features were imprinted on cotton, sometimes on silk, handkerchiefs in Glasgow.

Mr. J. ORROCK said he was totally unacquainted with the practical working of lithography, but he might say with perfect truth that there was no medium at all which had done so much for the English landscape painter, or so directly conveyed the art direct from the master, as lithography. John Ruskin himself admitted, and he was a great admirer of everything solid and sound, that Harding's works on trees were probably the finest things the world had ever seen: he had not only expressed them in the most exquisite manner, as Mr. Simpson had said, but he did them with his own hand, a thing which could never be said with regard to line engraving, though it sometimes could in the case of etchings. Some might say that Sidney Cooper was not a great artist, but he contended that he had been the English Adrian Vandervelde, and produced most beautiful works. His lithographs had been most valuable to all artists, and if they were candid, many of them would have to admit

that they had stolen no end of material from him. Lithography was a living art, a lasting art, and he was quite sure it would never die.

The CHAIRMAN said, except as a very old friend of Mr. Simpson and the successor of Mr. Louis Haghe, he should not have felt justified in taking the chair that evening, as he had a very limited experience of the art of lithography, though he was not entirely ignorant of the processes. Some of his best friends had been workers in this art, and through them he gathered many valuable experiences. He remembered very well an old friend of his, Mr. Way, attempting to revive artistic lithography by calling in the aid of himself and several other members of the Hogarth Club. About twelve or fourteen of them met at his house, when he supplied them with stones, and gave them some idea how to proceed. The result far exceeded their expectations. Of course they were like all men working on a new process, they dreaded it at first; they were told all sorts of difficulties would arise, and so on, but when they tried they found a great deal of this was imaginary, and that, with ordinary precautions, you could draw as readily and easily as on paper. Although the results were not so admirable as they would have been had they been more practised, still the volume existed, and would testify that many of those works were, to say the least, very creditable. Among the processes mentioned that evening was one which had always possessed the highest interest to himself, and which he was delighted to see revived, the litho-tint. The idea had been ventilated whether there might be a revival of the processes which should be artistic, and yet be commercially valuable, because, after all, nothing would succeed in publications unless it were commercially successful. The old litho-tint, as he remembered it, seemed to him admirably adapted for the purpose. He had never worked it himself, but, he should say, it was a rapid process, extremely beautiful, and was the direct work of the artist himself. Some might remember one or two productions, such as those of Cattermole. Some he remembered illustrating Shakespeare—Macbeth, particularly the witches' scene—and there were others by Frederick Tayler, amongst them a boar hunt, which he considered one of the finest works of art Frederick Tayler produced. He could not help thinking that, if litho-tinting were treated in the sense that artists now treated etching, it would meet with the same success. He had been told that the processes under which these works were executed was, to a large extent, a lost art; they were executed in the time of Hullmandel, who was a great inventive genius in the processes of lithography, and, amongst the rest, perfected this; whilst Cattermole, Tayler, and others were executing these works, keeping no notes, he actually lost the art when it had reached its finest point, and it had never been re-discovered in its perfection. Still there was a process

of litho-tint existing which was capable of doing a great deal. He feared Mr. Brooks had led the audience to suppose that Mr. Simpson had stated that lithography was a dead art, but he had done nothing of the kind. He merely made the statement with regard to one branch, viz., its use for illustrating books and passing events. But as a whole of course it was not dead. It might not be so strong in some directions as it once was, but all arts were subject to that contingency. He concluded by proposing a very hearty vote of thanks to Mr. Simpson.

Mr. SIMPSON, in acknowledging the vote of thanks, said, after what the Chairman had expressed, there was hardly anything for him to answer. He might tell Mr. Stannus, however, that he was now connected with wood-cutting so intimately, that he should be very sorry indeed if that art were in any way to be superseded. Of course he had no intention of saying that lithography was dead at all, but there need be no doubt regarding the great change which had been described in the paper, and which Mr. Brooks had, to a certain extent, described himself. There were many things which lithography would do better than anything else, but there was nothing done in it at the present day like some of the books on the table. His list of names was not at all complete, and he was very glad that Mr. Brooks had added to it, and it would be well if others would do the same, so that the list might be fuller for reference hereafter.

Mr. W. GRIGGS writes:—I much regretted I was unable, when called upon, to say a few words on the subject matter of the paper read by Mr. Simpson, but I was suffering from partial deafness, through a bad cold. I understood Mr. Simpson to speak of the lithographic art as having its day, and the "finished chapter" seemed to imply that it was a lost art. Had I been quite sure that this was the theme, I should have tried to prove that, instead of the lithographic art having declined, it has made immense strides since the "fifties," and has not yet nearly reached its zenith. To Mr. Simpson's remark, "I would say to the artists, let them try the stone," I hope only real workmen will take this hint. The "nineties" demand realistic work, not the untruthfulness of some so-called artists of the present day who affect æstheticism. Mr. Simpson's glowing word picture of the good work done up to the "fifties" was fully proved by the excellent examples placed before the meeting, the bulk of which, I think, must be classed as luxuries only for the well-to-do. Mr. Simpson practically stopped at the luxurious art side of lithography in the "fifties." But it has extended enormously since then, and has thrown out branches of analogous methods of printing which are more real, more true to what they pretend to depict, than any work done with pure hand work that I have ever seen. To-day, we have to produce in as many hours, and for as many

shillings, as in the good old "fifties" artists were allowed days and guineas. Mr. Simpson has furnished us with a splendid art *resumé* of lithography up to the "fifties," this wants bringing up to date—the "nineties"—from the hand-press of 150 pulls per day, to the present production from machine of 4,000 per day.

NINTH ORDINARY MEETING.

Wednesday, February 4th, 1891; SIR HENRY E. ROSCOE, M.P., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Brumleu, William Charles, 7, Mincing-lane, E.C.
Carpenter, Charles Claude, Bridge Foot, Vauxhall, S.E.
Coxeter, Samuel J., Woodlands, Gloucester-road, New Barnet.
Petit, Hon. Sir Dinshaw Manockjee, Petit-hall, Malabar-hill, Bombay.
Piper, Edward Jesse, Rose-cottage, Sidcup, Kent.
Richards, William Armstrong, Hillside, Sandbach, Cheshire.

The following candidates were balloted for, and duly elected members of the Society:—

Broadbent, Harry, 31, Victoria-terrace, Belle Vue-road, Leeds.
Craggs, John George, Stone-house, St. John's, S.E.
Darnley, Earl of, Cobham-hall, Gravesend.
Holtzapffel, John J., 64, Charing-cross, S.W.
Rawcliffe, Henry, J.P., Pool Bank, New Ferry, Birkenhead.
Rhodes, George Webber, 131, Wool-exchange, E.C.
Weld-Blundell, Herbert, 104B, Mount-street, W.

The paper read was—

DECIMAL COINAGE, WEIGHTS, AND MEASURES.

By J. EMERSON DOWSON, M.INST.C.E.

For some sixty years or more the question of having a decimal system of coinage, weights, and measures in this country has received more or less attention, and several public inquiries have been held; but I venture to say that the subject has not been dealt with as comprehensively and as exhaustively as it deserves. So long ago as 1841, when the Houses of Parliament were destroyed by fire, the Commissioners appointed, in consequence of the destruction of the standards of weight and measures, referred incidentally in their report to the advantages of decimal coinage,

weights, and measures; and, two years later, a new Commission referred to and confirmed this opinion. In 1853, the appointment of a Select Committee to inquire into the whole subject of decimalising moneys, weights, and measures was proposed; but, unfortunately, its scope was limited to moneys only when the appointment was made. This Committee reported strongly in favour of a decimal coinage, and recommended what is known as the "pound and mil system." In 1857, a Royal Commission was appointed to consider the introduction of a decimal coinage; and, in their preliminary report, the Commissioners said that the question of decimalising the weights and measures was early forced on their notice, but that they could not deal with it, as the terms of the Commission "restricted their investigations to the practicability and expediency of introducing the decimal principle into the coinage of this country, without contemplating any change in our present system of weights and measures." In their final report, two years later, they were, however, so far impressed with the intimate connection between the weights, measures, and coins, that they remarked: "It does not appear desirable under existing circumstances, while our weights and measures remain as at present, and so long as the principle on which their simplification ought to be founded is undetermined, to disturb the established habits of the people with regard to the coins now in use, by a partial attempt to introduce any new principle into the coinage alone." This was the last inquiry into the coinage question; but in 1862 a Select Committee was appointed to report on "the practicability of adopting a simple and uniform system of weights and measures." They reported strongly in favour of the metric system, but incidentally the question of decimal coinage was forced upon them; and they added in their report that "the evidence they have received tends to convince them that a decimal system of money should, as nearly as possible, accompany a decimal system of weights and measures," so as to obtain the greatest advantage.

In these inquiries an immense amount of valuable information was got together, but no Committee or Royal Commission was instructed to deal with the subject of coins, weights and measures as a whole, or to consider the intimate relations of one to the other. I am an advocate of the decimal system, but I say at once that the trouble and expense of disturbing our present coinage would not be

repaid if our partly duodecimal and partly mixed weights and measures were not also to be changed eventually, so as to harmonise with the coinage. It is true there are special reasons why the metric system of weights and measures should be adopted, independently of the question of coinage, but it cannot be doubted that the gain would be still greater if the whole were on a decimal basis. It would be Utopian to suppose that all could be changed at once, but a complete, though gradual change should be contemplated. Probably it would be best to change the weights and measures first, and then the coinage, as the former could be changed in a comparatively short time, whereas a longer time must elapse for the old coins to take the place of the new. It would also be less difficult to adjust the new weights and measures to the old coins, than to adjust new coins to the old weights and measures. The whole subject should be most thoroughly investigated in its broadest and most detailed aspect, and if the valuable inquiries already held had been less piecemeal in their constitution, and if the Committee of 1853 had not recommended an unpopular system for the coinage, there is every probability that at the present time we should be using decimal coins, weights, and measures.

The subject itself is an old one, but for this very reason I may be allowed to recall some of the points connected with it. As a general proposition, its importance has never been questioned, but from the practical point of view much depends on certain details which it is essential to consider. In the first place, I may remind you that some contend that a system based on the number 10 is inferior, *per se*, to one based on 8 or 12, but the fact remains that throughout the civilised world a decimal system of notation has been adopted, and cannot now be changed; therefore the real question is whether we should not reckon our coinage, weights, and measures, according to the universal basis of notation. The counting by tens is no doubt due to the simple fact that human beings have ten fingers, and that, primitively, they were used as the means of calculation; hence the whole world stands committed to the decimal notation as the basis of its arithmetic. It is true that the number 10 is not divisible by certain numbers, as, for instance, by 3, without remainder, and it is sometimes urged that this is a fatal objection to the use of the decimal system. But the advantage of having a system of weights,

measures, and coinage in unison with the basis of notation far outweighs this objection. It is, moreover, a mistake to suppose that if such a system were generally adopted, vulgar fractions must in no case be used; and as the late Professor De Morgan remarked, "It is an abiding delusion of the opponent of decimals that he *will* suppose the decimalist to be under a contract never to use a common fraction." Decimals are not upheld as exclusively right, but rather as pre-eminently convenient; and when in certain cases it is quicker or more accurate to use vulgar fractions, undoubtedly they should be used. When the late Mr. Beresford Hope spoke, in the House of Commons, against the introduction of the metric system, he tried to make much of this very point, and said:—"If a boy has to divide an apple, does he ever think anything about the circumference of the earth and its aliquot parts, or about the decimal system and its unrivalled facilities for calculation? No; but he takes his apple, and cuts it into two parts if he wants to halve it, and those halves into quarters if he wants to make four parts of it. In the same way, if a housewife has to cut up a loaf for her family, she divides it in two, into four, into eight, or into sixteen parts."* No one can gainsay this, but what has it to do with the practical adoption of the decimal system for general purposes? Mr. Beresford Hope, however, went further, and said:—"Supposing the loaf to weigh originally a pound, each of these sixteen divisions comes to an ounce." But one might reply that, supposing the housewife had to divide the loaf into five, ten, or fifteen parts of equal weight, she could not do so with the ordinary household weights of pounds and ounces, whereas in the metric system it would be quite easy. Such criticisms are really beside the main question, for no system is best under all circumstances; and, from a practical point of view, we have to select that which presents the greatest number of advantages. On this point it is reassuring to know that wherever a decimal system of coinage or of weights and measures has been adopted, no practical difficulty has been experienced in subdivision. In fact, the importance of dividing without a remainder has been greatly overrated.

The opinions of many competent authorities might be quoted in support of this statement, but let us rather seek the result of actual experience in other countries. In the first place we find, on referring to Table A, and to

* Hansard, vol xciii., p. 187.

MAP OF THE WORLD.
COUNTRIES USING DECIMAL COINAGE ARE SHADED. CIVILISED COUNTRIES NOT USING DECIMAL COINAGE ARE BLACK.



Walker & Boultbee.

TABLE A.—(1) COUNTRIES USING DECIMAL COINAGE.

Reference No. on Map.	Country.	Standard Coin or Token.	Sub-divisions.
34	Algeria	Franc	100 centimes
2	America (United States)	Dollar	100 cents
13	Argentina	Peso	100 cents
27	Austria-Hungary	Florin	100 kreuzer
22	Belgium	Franc	100 centimes
9	Bolivia	Dollar	100 cents
10	Brazil	Milreis	1000 reis
54	Bulgaria	Leva	100 stotinks
1	Canada	Dollar	100 cents
40	Ceylon	Ruppee	100 cents
14	Chile	Peso or Dollar	100 centavos
42	China	Tael	100 candaren
6	Colombia (Republic)	Peso or Dollar	100 centavos
20	Denmark	Krone	100 öre
7	Ecuador	Suere or Dollar	100 cents
35	Egypt	Egyptian pound	100 tariff piastres
52	Finland	Markka	100 penni
24	France	Franc	100 centimes
19	Germany	Mark	100 pfennige
33	Greece	Drachma	100 lepta
49	Haiti	Piastre or Dollar	100 cents
21	Holland	Florin or Guilder	100 cents
41	Hong Kong	Dollar	100 cents
32	Italy	Lire	100 centesimi
43	Japan	Yen	100 sens
51	Java	Florin or Guilder	100 cents
57	Madagascar	Dollar	100 cents
38	Mauritius	Ruppee	100 cents
3	Mexico	Peso or Dollar	100 cents
16	Norway	Krone	100 öre
11	Paraguay	Dollar	100 cents
8	Peru	Sol	100 centesimos
26	Portugal	Milreis	1000 reis
29	Roumania	Lei	100 centimes
18	Russia	Rouble	100 kopeck
28	Servia	Dinar	100 paras
25	Spain	Peseta	100 centimos
50	Straits Settlements	Dollar	100 cents
17	Sweden	Krone	100 öre
31	Switzerland	Franc	100 centimes
30	Turkey	Turkish pound	100 piastres
12	Uruguay	Peso or Dollar	100 centavos
4	Venezuela	Peso or Dollar	100 centavos

TABLE A.—(2) CIVILISED COUNTRIES NOT USING DECIMAL COINAGE.

Reference No. on Map.	Country.	Standard Coin or Token.	Sub-divisions.
23	Great Britain and Ireland British Possessions :—	Pound sterling.	20 shillings of 12 pence each.
47	Australia	do.	do.
36	Cape Colony	do.	do.
48	New Zealand	do.	do.
39	British India	Rupee	16 annas of 4 pice each.

TABLE B.—COUNTRIES USING METRIC WEIGHTS AND MEASURES.

Country.	Population.	Imports to Great Britain in 1889.	Exports from Great Britain in 1889.
		£	£
Norway and Sweden..	6,774,409	12,704,560	6,392,618
Denmark and Iceland	2,244,650	7,845,877	2,814,079
Danish West Indies...	33,763	5,029	83,464
Germany	46,855,704	27,104,832	31,148,731
Holland	4,450,870	26,679,216	16,183,786
Java, &c.	28,500,000	2,234,174	1,788,064
Belgium	6,030,943	17,674,877	13,609,575
France	38,218,903	45,780,277	22,101,222
Algeria	3,817,460	658,082	291,765
Senegambia	1,000,000	14,515	105,679
Portugal	4,306,554	3,105,076	2,991,961
Azores and Madeira	401,624	145,593	221,432
Spain		11,588,857	4,907,884
Canary Islands.....		123,191	436,104
Fernando Po.....	17,550,216	6,427	8,294
West India Islands		104,487	2,767,155
Philippine "		2,331,786	1,592,384
Italy	29,699,781	3,230,131	8,020,337
Austrian Territories...	41,827,700	2,286,834	1,392,090
Greece	2,187,208	1,864,297	937,253
Roumania	5,376,000	3,204,776	1,308,822
Turkey (in Europe) ...	4,668,000	5,265,373	6,744,663
Mexico	10,447,974	465,994	1,621,106
Central America	3,053,000	1,181,703	1,044,901
Haiti	550,000	47,123	262,690
Colombia (Republic)..	3,500,000	245,290	1,227,600
Venezuela	2,121,988	284,666	802,579
Ecuador	1,000,000	72,430	277,801
Brazil	14,000,000	5,070,628	6,750,349
Uruguay	700,000	450,531	2,469,663
Argentine Republic ...	4,200,000	2,016,182	10,897,690
Chili	2,665,926	3,264,573	3,229,963
Peru	2,970,000	1,293,977	1,073,689
Japan	39,607,234	977,606	4,055,386
Totals.....	328,759,007	£189,328,970	£159,560,779

the accompanying map of the world (p. 203), that at the present time a decimal system of coinage has been adopted by *every civilised country*, except Great Britain and *some* of her dependencies. Further than this, we find, on referring to Table B, that, in a large proportion of the civilised countries, the metric weights and measures have been adopted. It is, moreover, satisfactory to know that in no single instance has any country given up the decimal system after once adopting it. Great Britain has been true to her insular ways, and has held aloof; but the spread of the decimal system has steadily advanced in other countries, and for the reasons I will presently give, the question has become much more serious for us than it was even twenty years ago.

Let us for a moment consider some of the advantages of having a system of coinage, weights, and measures on the same basis as our present system of notation. Undoubtedly the most important is, that if the values of our coins, weights, and measures were founded on decimal relations, whole numbers and fractions could be added, subtracted, multiplied, and divided by the rules of simple arithmetic, and compound arithmetic would be entirely superseded. In our present system of coinage, to add together pounds, shillings, pence, and farthings, we must first add the farthings (expressed as vulgar fractions), and divide by 4, to reduce them to pence; we must then add the pence, and divide by 12; then the shillings, and divide by 20; and, in each case, we must carry forward a number resulting from the reduction. The same may be said for subtraction; but in multiplication and division the difficulties are still greater, and many more figures are usually necessary. In all cases there is, of course, more labour and much more mental exertion than are expressed by the mere

figures set down. In a decimal system, neither reductions nor divisions are necessary; and

the working is thereby greatly simplified, as the following examples forcibly show:—

TABLE C.

ENGLISH COINAGE.

ADDITION.

£	s.	d.
56	16	$8\frac{1}{4}$
123	19	$6\frac{1}{2}$
45	13	$9\frac{3}{4}$
27	11	$2\frac{3}{4}$

Ans. 254 1 $3\frac{1}{4}$

SUBTRACTION.

£	s.	d.
106	8	$7\frac{1}{4}$
82	18	$8\frac{3}{4}$

Ans. 23 9 $10\frac{1}{2}$

MULTIPLICATION.

Multiply 89 17 $11\frac{3}{4}$ *by* 57

57
3

4)171

12)42 + $\frac{3}{4}$

3 + 6 = 0 3 $6\frac{3}{4}$

57
11

12)627

20)52 + 3

12 + 12 = 2 12 3

57
17

399

57

20)969

48 + 9 = 48 9 0

57
89

513

456

5073

5073 0 0

Ans. £5124 4 $9\frac{3}{4}$

Another method of working:

£ s. d.
89 17 $11\frac{3}{4}$ × 57
5

449 9 $10\frac{3}{4}$
10

4494 18 $11\frac{1}{2}$
629 5 $10\frac{1}{4}$

Ans. £5124 4 $9\frac{3}{4}$

FRENCH COINAGE.

ADDITION.

Frs. Cts.

1420'85

3099'42

1142'26

689'03

Ans. 6351'56

SUBTRACTION.

Frs. Cts.

2660'75

2091'41

Ans. 569'34

MULTIPLICATION.

Frs. Cts.

Multiply 2247'47 *by* 57

2247'47

57

1573'29

1123'75

Ans. 128105'79

DIVISION.			
<i>f.</i>	<i>s.</i>	<i>d.</i>	
<i>Divide</i> 89	17	$11\frac{3}{4}$	<i>by</i> 57
57)89(1			
57			
—			
32			
20			
—			
640			
17			
—			
57)657(11s.			
57			
—			
87			
57			
—			
30			
12			
—			
360			
11			
—			
57)371(6d.			
342			
—			
29			
4			
—			
116			
3			
—			
57)119(2 fgs.			
114			
—			
5			
<i>Ans.</i> 1 11s. $6\frac{1}{2}$ d.			

DIVISION.	
<i>Frs.</i>	<i>Cts.</i>
<i>Divide</i> 2247'47	<i>by</i> 57
	<i>Fr. c.</i>
57)2247'47(39'42	
171	
—	
537	
513	
—	
244	
228	
—	
167	
114	
—	
53	

Fr. c.
Ans. 39'42

In the weights we now use, to add together tons, hundredweights, quarters, pounds, and ounces, we must first add up the ounces and divide by 16; then the pounds and divide by 28; then the quarters and divide by 4; then the hundredweights and divide by 20; and in each case we must carry forward a number resulting from the reduction. If we used the metric system, any number of tons or kilo-

grams, and any number of fractional parts could be added together by simple addition. The same is true of measures of length, surface and capacity; in all cases the addition, subtraction, multiplication, and division decimally, can be done by simple arithmetic. Let us take, for instance, the following examples:—

TABLE D.

ENGLISH WEIGHTS.				
ADDITION.				
	Tons.	cwt.	qr.	lb.
<i>Add together</i> 1	19	3	20	
3	16	2	16	
4	9	1	18	
5	11	3	15	
<i>Ans.</i> 15	17	3	13	

METRIC WEIGHTS.	
ADDITION.	
	Kilograms.
<i>Add together</i> 2032'72	
3901'82	
4551'82	
5695'91	
<i>Ans.</i> 16182'27	

SUBTRACTION.

	Tons.	cwt.	qr.	lb.
<i>From</i>	1	11	2	3
<i>Subtract</i>		18	3	26
<i>Ans.</i>		12	2	5

MULTIPLICATION.

	Tons.	cwt.	qr.	lb.
<i>Multiply</i>	16	18	3	21 by 78
	20			
	338			
	4			
	1355			
	28			
	10861			
	2710			
	37961			
	78			
	303688			
	265727			

28)2960958(105748 qrs.

28
160
140
209
196
135
112
238
224
14 lb.

4)105748

2,0)2643.7

1321,17

	Tons.	cwt.	qr.	lb.
<i>Ans.</i>	1321	17	0	14

Another method of working.

	Tons.	cwt.	qr.	lb.
	16	18	3	21
				10
	169	9	1	14
				7
	1186	5	2	14
	135	11	2	0
<i>Ans.</i>	1321	17	0	14

SUBTRACTION.

	Kilograms.
<i>From</i>	1605.00
<i>Subtract</i>	966.36
<i>Ans.</i>	638.64

MULTIPLICATION.

	Kilograms.
<i>Multiply</i>	17255
<i>by</i>	78
	138040
	120785
<i>Ans.</i>	1345890

DIVISION.

	Tons.	cwt.	qr.	sb.
<i>Divide</i>	16	18	3	21 by 78
	20			
	338			
	4			
	1355			
	28			
	10861			
	2710			
	78)37961	(486 $\frac{2}{3}$ lb.		
	312			
	676			
	624			
	521			
	468			
	53			
28)486	17 qrs.		4)17	
28			4, 1	
206				
196				
10				
	Cwt	qrs.	lb.	
<i>Ans.</i>	4	1	10 $\frac{2}{3}$	

DIVISION.			
<i>Divide</i> 17255 Kilograms by 78			
	78)17255	(221'21	
	156		
	165		
	156		
	95		
	78		
	170		
	156		
	140		
	78		
	62		
	Kilos		
<i>Ans.</i>	221'21		

The fact is that we cannot add, subtract, multiply, or divide our present weights and measures without learning and remembering or consulting many inconsistent and incongruous tables. Moreover, the sub-divisions of these weights and measures are most arbitrary; and as they are not based on any one system of multiples, special reductions are necessary for each sub-division. If, for instance, we follow the working of the example given in Table E, which is of an ordinary kind, and which is given in two ways, it will be seen that in both, the number of figures required, and the difficulty of avoiding mistakes, are really serious. In the second way of working *practice* has been used, as this is shorter than the other; but it should be remembered that *practice* is known to comparatively few, that it involves mental calculations not shown on paper, and that with it there are often difficulties with the odd fractions. On the other hand, the working by decimals is of the simplest kind.

Calculations of interest are also simplified immensely by having a decimal system of

TABLE E.

Give the cost of 215 tons 17cwts. 3 qrs. 9 lbs. at £9 11s. 6d. per ton.

Cwt.	Tons.	cwt.	qrs.	lbs.	£	d.	s.
20	215	17	3	9	9	11	6
4	20				20		
80	4317				191		
28	4				12		
640	17271				2298	pence.	
160	28						
2240 lbs. per ton.	138177						
	34542						
	483597						
	2298						
	3868776						
	4352373						
	967194						
	967194						
	1111305806						

224,0)111130580,6(496118 pence.

896

2153
20161370
1344265
224418
2241940
1792

148

$$\frac{148}{224} = \frac{3}{4} \text{ pence.}$$

12)496118

2,0)4134,3 2
2067 3

Ans. £2067 3s. 2½d.

The same worked by Practice:—

215 tons at £9 a ton = £1935 0 0

,, 10s. = (½ of £).. 107 10 0

,, 1s. = (1/10 of 10s. 10 15 0

,, 6d. = (½ of 1s... 5 7 6

£2058 12 6

215 tons at £9 11s. 6d. a ton = £2058 12 6

10 cwt. = ½ of 1 ton 4 15 9

5 cwt. = ½ of 10 cwt. 2 7 10½

2 cwt. = 1/10 of a ton 0 19 2

2 qrs. = ¼ of 2 cwt. 0 4 9½

1 qr. = ½ of 2 qrs. 0 2 4¾

7 lbs. = ¼ of qr. 0 0 7¼

2 lbs. = 1/14 of 1 qr. 0 0 2

£2067 3 3

*Note.—The mental calculations involved in this example are not shown.*Give the cost of 375620 kilograms, at
£8 4fl. 5c. per 1000 kilos.

375·620

8·45

1878100

1502480

3004960

3173·98900

Ans. £3173 9fl. 89c.

coinage, as shown in Table F (p. 211). In the decimal examples I have used the system of coinage shown in Table H (p. 215), but any other decimal system could be used.

I may here mention incidentally that the slide rule (which I believe was invented by an Englishman) is little used in this country, because it depends largely on decimal multiples and fractions. It is, however, a time-saving instrument, very easy to understand, and in France it is extensively used by managers of factories, by engineers, foremen, and others. It leads to accuracy and rapid calculation, while at the same time it exercises the mental process of carrying figures in the head. Then, again, there is the calculating machine, which has been so intimately associated in this country with the name of the late Mr. Babbage, but which is seldom used here. On the other hand, in France, where decimals are commonly used, 1,500 of the machines of M. Thomas of Colmar have been sold during the last twelve years. This machine is much used in banks, insurance offices, manufactories, and large houses of business, of all kinds, in naval and military departments, in technical colleges, such as the Ecole Polytechnique, the Ecole des Ponts et Chaussées, and in most of the railway offices, &c.* A machine of this make, capable of multiplying, dividing, &c., six figures by six figures, costs only £16, or about a third less than a good type-writer, and its working is more easily learnt than that of the latter. Provided decimals can be used, there is no reason why the calculating machine should not be used as generally as the type-writer by bankers, merchants, brokers, engineers, statisticians, and by all who have long calculations to make.

It is beyond question that if a decimal system of coins, weights, and measures were adopted in this country, the saving in time to manufacturers and business men of all kinds would be enormous. Much valuable time would also be saved in the education of the young, as compound arithmetic would no longer be necessary. To form an idea of the complexity of the rules now required, let us take the case of the most elementary teaching under the Code of the Education Department, and we shall find that the subjects of examination in arithmetic are as follow:—

STANDARD III.—The four simple rules, with long division. Multiplication and pence tables, and addition and subtraction of money.

STANDARD IV.—Compound rules (money) and reduction of common weights and measures.

The tables to be learned include:—

* For further particulars see Report by Committee of Société d'Encouragement pour l'Industrie Nationale, on the "Arithmometer," Dec. 13, 1878.

TABLE F.

PRESENT SYSTEM.

Simple interest, at 4 per cent., on

£	s.	d.
156	12	10
		4
<hr/>		
6,26	11	4
	20	
<hr/>		
5,31		
	12	
<hr/>		
3,76		
	4	
<hr/>		

Ans. £ 6 s. d.
6 5 3 $\frac{3}{4}$

3,04

Compound interest on £186 18s. 8d. for 3 years at 3 per cent. :—

£	s.	d.
186	18	8
		3
<hr/>		
5,60	16	0
	20	
<hr/>		
12,16		
	12	
<hr/>		
1,92		
	4	
<hr/>		
3,68		
<hr/>		
5	12	1 $\frac{3}{4}$
186	18	8
<hr/>		
192	10	9 $\frac{3}{4}$
		3
<hr/>		
5,77	12	5 $\frac{1}{4}$
	20	
<hr/>		
15,52		
	12	
<hr/>		
6,29		
	4	
<hr/>		
1,17		
<hr/>		
5	15	6 $\frac{1}{4}$
192	10	9 $\frac{3}{4}$
<hr/>		
198	6	4
		3
<hr/>		
5,94	19	0
	20	
<hr/>		
18,99		
	12	
<hr/>		
11,88		
	4	
<hr/>		
3,52		

Ans. :—First year's interest..... £ 5 s. d.
Second „ „ 5 15 6 $\frac{1}{4}$
Third „ „ 6 18 11 $\frac{3}{4}$

DECIMAL SYSTEM.

Simple interest, at 4 per cent., on

£	fl.	c.
156	6	41
		4
<hr/>		
6265	64	

Ans. £ fl. c.
6 2 65

Compound interest on £186 9fl. 33c., for 3 years at 3 per cent. :—

£	fl.	c.
186	9	33
		3
<hr/>		
5607,99		
186933		
<hr/>		
192540		
		3
<hr/>		
5776,20		
192540		
<hr/>		
198316		
		3
<hr/>		
5949	48	

Ans. :—First year's interest £ fl. c.
Second „ „ 5 6 07
Third „ „ 5 7 76
Third „ „ 5 9 49

Weight.—The ton, cwt., quarter, stone, pound, ounce, and drachm.

Length.—The mile, furlong, rod or pole, chain yard, and inch.

Area.—The square mile, acre, rood, square pole or perch, the square yard, foot, and inch (Boys only).

Capacity.—The quarter, bushel, peck, gallon, quart, and pint.

STANDARD V.—Practice, bills of parcels, rule of three, and addition and subtraction of proper fractions with denominators not exceeding 12.

STANDARD VI.—Fractions, vulgar and decimal; simple proportion, and simple interest.

STANDARD VII.—Averages, per-centages, and stocks.

In Table G, I give a copy of the tables actually used in Standard IV., and it will be noted that the youthful mind has not only to master the intricacies of our ordinary coinage, but has to deal with such obsolete coins as

groats, dollars, crowns, guineas and moidores, while the much used rupee is not even referred to. Among the "Examples of Arithmetic carefully graduated for Standard IV.,"* I find the following:—How many stones of fish (8 lbs.) are of the same weight as 840 common stones? How many great pounds (24 oz.) are of the same weight as 365 common pounds? How many tierces in 590734 pints? How many rundlets in 58348 gills? In 4809 ells, how many nails? In 638 ells 1 quarter 2 nails, how many inches. Reduce 680305 inches to Flemish ells. This, then, is the actual teaching in our most elementary schools, where it may be supposed there is some desire to simplify the rules; but to put it mildly, can any one say that such rules and examples are not much more difficult, complicated, and bewildering than would be the case if a decimal system were adopted as the basis of

TABLE G.—TABLES OF MONEY, WEIGHTS, AND MEASURES, FOR STANDARD IV.

STERLING MONEY.

4 Farthings	1 Penny	— <i>d</i> .
4 Pence	1 Groat.	
12 Pence	1 Shilling	— <i>s</i> .
2 Shillings	1 Florin.	
2 Shillings and sixpence ..	1 Half-crown.	
4 Shillings and twopence..	1 Dollar.	
5 Shillings	1 Crown	— <i>cr</i> .
20 Shillings	1 Pound	— <i>£</i> .
21 Shillings	1 Guinea.	
27 Shillings	1 Moidore.	

AVOIRDUPOIS WEIGHT.

For all Goods, except Gold, Silver, and Jewels.

16 Drams	1 Ounce	— <i>oz</i> .
16 Ounces	1 Pound	— <i>lb</i> .
28 Pounds	1 Quarter	— <i>qr</i> .
4 Quarters	{ 1 Hundred- weight— <i>cwt</i> .	
20 Cwt.	1 Ton.	

14 Pounds	1 Stone.	
8 Stone	1 Cwt.	
112 Pounds	1 Cwt.	
2240 Pounds	1 Ton.	

LONG MEASURE.

12 Inches	1 Foot	— <i>ft</i> .
3 Feet	1 Yard	— <i>yd</i> .
5½ Yards	{ 1 Rod, Pole, or Perch	
40 Poles	1 Furlong— <i>fur</i> .	
8 Furlongs	1 Mile.	
3 Miles	1 League.	
4 Poles, or 22 yards	1 Chain.	
220 Yards	1 Furlong.	
1760 Yards	1 Mile.	
5280 Feet	1 Mile.	

SQUARE MEASURE.

144 Square inches ..	1 Square foot.	
9 Square feet	1 Square yard.	
30¼ Square yards	1 Square pole.	
40 Square poles	1 Rood.	
4 Roods	1 Acre.	
640 Acres	1 Square Mile.	
4840 Square yards	1 Acre.	

MEASURE OF CAPACITY.

4 Gills	1 Pint.	
2 Pints	1 Quart.	
4 Quarts	1 Gallon.	
2 Gallons	1 Peck.	
4 Pecks	1 Bushel.	
8 Bushels	1 Quarter.	

calculation? With the best intention on the part of the teachers to teach intelligently, it must indeed be extremely difficult for them to deal with such unsystematised weights and measures as those prescribed. Not only is the teaching in these elementary schools rendered unnecessarily difficult, but, as it is usual to devote one hour each day to arithmetic, and as each scholar is supposed to be about one year in each standard, it follows that at least two years' teaching in arithmetic is now taken up by subjects which a decimal system would render wholly unnecessary.

In the elementary schools of Belgium and France, for instance, there is nothing more impressive than the great simplicity of their arithmetic, compared with ours. In the first place, the scholars are taught to count by units, tens, hundreds, &c., and then to add whole numbers decimally, as in this country. Immediately afterwards they are taught to add fractions decimally just in the same way as whole numbers; and then they are taught in turn the subtraction, multiplication, and division decimally of whole numbers and of fractions. Presented in this simple and natural way, the working of decimal fractions and multiples is no more difficult than that of whole numbers; and as soon as these simple rules have been mastered, all ordinary calculations in the money of these countries can be performed with the greatest ease. There are no money tables to learn, and there are no reductions and complications, as with the coinage of this country. For weights and measures it is only necessary to learn the short and simple tables of the metric system, and then all calculations follow in the same easy way as with the decimal money. The young scholar is not perplexed with three denominations of coins, and long lists of arbitrary weights and measures which he cannot understand, and which to a great extent he forgets as soon as he leaves school. Instead of this, he learns to count by tens, and then to reckon money, weights, and measures on one and the same simple and consistent decimal basis. It really makes one angry to think of the thousands of boys and girls in our own country who are devoting thousands upon thousands of hours to the absurd and antiquated methods we still cling to, when a simple and rational system could be learnt as part and parcel of the four simple rules of arithmetic.

In the face of this, one is glad to point out any indication, be it ever so slight, of the lift-

ing of the dark cloud of prejudice and indifference which has been hanging over us so long, and to call attention to the first streak of blue which has made its appearance in recent times. In June last a memorial was presented to the School Board of London by the Decimal Association, praying that decimals may be taught on completion of the four simple rules, and before the scholars have to take up the compound rules, for money, weights, and measures; and I am pleased to state that the following reply has been received by the Secretary of the Association:—

"School Board for London,

"22nd October, 1890.

"SIR,—Adverting to your Association's memorial on the decimal system, which was submitted to the Board on the 26th June last, I am directed to inform you that, on the recommendation of the School Management Committee, the Board have written to the Education Department, asking them to modify Schedule I of the new Code, so that decimal fractions shall be taught in the Fourth Standard, at latest, and that the metric system of measurement be included in the teaching of the Fourth and Upper Standards. The School Management Committee of the Board have also decided that models, illustrating the metric system, shall be added to the Board's Requisition List, in the event of the Education Department accepting the proposal of the Board.

"I am, Sir, your obedient servant,

(Signed) "G. H. CROAD,

"Clerk of the Board."

Since then, 37 other School Boards have petitioned the Education Department in the same sense, and others are preparing to do so. Among those which have already sent in petitions may be mentioned the School Boards of such important towns as Birmingham, Coventry, Derby, Hull, Hartlepool (West), Ipswich, Leeds, Leicester, Norwich, Oldham, Plymouth, Salford, Sheffield, and Swansea.

The educational aspect of the decimal question is very much more important than it was in 1862, when the last Royal Commission was appointed. Since then, elementary education throughout the country has been made compulsory; the Board Schools are largely maintained by the ratepayers; they are managed by representatives of the ratepayers; and they are under Government supervision. Elementary education is, therefore, on a broad public basis, and it is essential that the time and abilities of the teachers and scholars should be devoted only to subjects which will bear fruit in after life. Much has been done in this direction, but, as we know from Dr.

Gladstone and other competent authorities who have addressed this Society, reforms are still necessary; and among them there can surely be none more important than the simplifying of the arithmetic by the adoption of a decimal system of coinage, weights, and measures. I do not expect, nor do I desire, that the School Boards should carry out such a reform single-handed. They must be strengthened by public opinion and official sanction, and they cannot omit the teaching of our present system until our coinage or our weights and measures are changed. At the same time it is most satisfactory to find that so many School Boards have recognised the importance of the decimal question, and have gone so far as to petition the Education Department to allow them to prepare the minds of the rising generation of scholars for the adoption of decimal weights and measures. There must be action and reaction; the public must adopt a decimal system, and the schools must prepare their scholars to understand and use it.

It has been urged by some, that if we do away with our present complex system of arithmetic, and if we confine ourselves to decimals, the mental gymnastics which are so good for the young will to a great extent be lost. Were this true, I admit that it would be a serious loss indeed, for I incline to the belief that it is even more important for young scholars to cultivate the power of learning than to acquire actual knowledge. I do not for a moment suppose that it is not beneficial for the young to practise mental arithmetic, and to work out problems of all kinds, but I do say that these exercises should have reference to subjects which are of daily occurrence in after life, rather than to obsolete and puzzling denominations of coins, weights, and measures which are utterly useless. I have examined a good many foreign books on arithmetic, and in all of them I find endless examples, based on the metric system, which are at least as good as those given in English arithmetics. The objections raised to the decimal system on this score are, I think, due to imperfect knowledge of the subject. As a matter of fact, this system not only simplifies the teaching of the young, but it is logical, and lends itself to the best kind of mental training.

COINAGE.

Having considered the general aspect of the decimal question, I will now notice briefly some

points of detail concerning the coinage. It is fairly easy to show that a decimal system of coinage would be more convenient than our present system, and most of the objections urged against it have reference to the period of transition rather than to the permanent effect. The practical difficulty is how to effect the change, and it is on this point that there has been the greatest diversity of opinion. In the first place, it is necessary to agree upon a standard unit, and then to settle upon coins which represent multiples and fractional parts of it, and are sufficient to meet all reasonable requirements. At the same time, it is essential that as few as possible of our present coins should be changed.

One proposal is to take the present farthing as a unit, so that the smaller coins now in use may be preserved, and retail prices in pence need not be altered. This, however, would involve giving a new value of 20s. 10d. to the pound, because it is now made up of 960 farthings, whereas it should be worth 1,000, to be divisible decimally. This would not only upset all contracts of large amount, and all large price quotations, but it would involve an alteration of our present gold coinage; and this is quite impracticable.

Another proposal is to have a dollar unit, worth 4s., divided into 100 cents; but the lowest coin would then represent nearly one $\frac{1}{3}$ d.; and, as the present 4s. piece represents only 48 pence, or 96 of the proposed cents, the existing copper coins would have to be changed, or a new value given to them.

To meet this last difficulty, it has been proposed to have a dollar worth 4s. 2d., as this would represent 50 pence, or 100 cents of $\frac{1}{2}$ d. each. The existing small coins could then be retained, but the pound sterling would have to be raised in value to 20s. 10d., or pass as \$4 80 cents, and this, I think, must be an insuperable objection. The Select Committee of 1853, and many high scientific authorities, as well as nearly all the Chambers of Commerce throughout the country, agreed as to the impossibility of abandoning the pound sterling as the highest integer of account. More recently, in February, 1888, when the question was brought before the Glasgow Chamber of Commerce, an overwhelming majority voted for the sovereign; the dollar of 4s. received only one vote besides those of the proposer and seconder; and the dollar of 4s. 2d. was not even seconded. Last year practically the same result followed in the Edinburgh Chamber of Commerce.

Presuming that the pound sterling would be retained, it was suggested that it should be divided into 1,000 mils or farthings, and this system was reported on very favourably by the Select Committee of 1853, but was not recommended by the Royal Commission of 1857. In this system the value of the copper coins would have been altered, but a still greater objection was that the poorer and less educated classes would have great difficulty in reckoning in thousandths of a pound, and in treating a penny, for instance, as $\cdot 004$ of a pound. Such a system might be good for accountants and skilled book-keepers, but it would hardly be suitable for the daily requirements of all classes, and as the *Times* of that date remarked: "It is deficient in that element of popularity which goes for so little in devising a scheme, and for so much in carrying it out."

Probably the best system would be that advocated so long ago as 1824 by Sir John (afterwards Lord) Wrottesley, who suggested as units—pounds, double shillings (florins were not then coined), and farthings. In Table H. I give a comparison of this system with our present coins, and it will be seen that if it is adopted, all our present coins, with the exception of the threepenny-piece, can be retained, but it will probably be desirable to have new coins of five, ten, and twenty cents each.

TABLE H.—SYSTEM OF DECIMAL COINAGE
BASED ON LORD WROTTESELEY'S PROPOSAL OF
1824.

Present Coins.			Proposed equivalents.		
Pounds.	Shillings.	Pence.	Pounds.	Florins.	Farthings or Cents.
1	—	—	1	—	—
—	10	—	—	5	—
—	5	—	—	2	50
—	4	—	—	2	—
—	2	6	—	1	25
—	2	—	—	1	—
—	1	—	—	—	50
—	—	6	—	—	25
—	—	3	—	—	—
—	—	1	—	—	04
—	—	$\frac{1}{2}$	—	—	02
—	—	$\frac{1}{4}$	—	—	01

One advantage of this system is that the cent is made to represent a farthing, instead of a halfpenny, as in the dollar proposals, so that smaller transactions can be effected.

There remains, however, the difficulty that the pound sterling represents only 960 farthings, and that a new value would have to be given to the existing copper coins, so that the sovereign may represent 1,000 farthings or cents. The copper coins being mere tokens, a new value could be given to them, and the only practical difficulty would be that the new farthing would represent $\frac{2}{3}$ ths of the present farthings, or 4 per cent. less; and to a certain extent this would affect retail prices based on present values. The period of transition would doubtless be troublesome, as it must be with any system, but it is tolerably certain that it would not be nearly so serious as was imagined by some of the witnesses before the Royal Commission of 1857. Since then, decimal systems of coinage have been adopted in many countries, among them Spain (1859), Portugal and Peru (1860), Brazil and Uruguay (1862), Chili, Belgium, Italy and Switzerland (1865), Mexico (1867), German Empire (1870), Ceylon (1872), Denmark, Norway, Sweden, Servia, and Holland (1875), Austria, Roumania, and Egypt (1876), Turkey (1882), Argentina (1887), and in no case have serious difficulties been encountered, and in no case has the decimal system been abandoned since. Ceylon is perhaps the best instance I can quote, as our English system of pounds, shillings, and pence was changed for a decimal system of rupees and cents, with the happiest results. The change was proposed in 1869, but the opposition to it was very great, and a Committee appointed by the Government to consider the question rejected it. Eventually, however, the opposition was overcome, largely owing to the able advocacy of the former Director of Public Works (Sir Guildford Molesworth), and the new decimal coinage was adopted. Only six weeks after the change was effected, the Financial Secretary of the Public Works Department (Mr. Ralph Tatham) wrote that:—

"All the necessary changes in the accounts, stamps, tolls, &c., have been effected without the slightest hitch or difficulty of any kind; in fact, the change is so little felt, that people have ceased to talk about it."

After four and a half years' experience, the manager of the Chartered Mercantile Bank, Colombo (Mr. James Robertson), wrote:—

"I sat on the Commission appointed by Sir Hercules Robinson to consider the currency question, and it was my opinion at the time that should we make the rupee the legal currency, we ought to follow India in the smaller denominations. However, I

have long since changed my views on this point, as practical experience has proved to me the advantage of the decimal subdivision of the rupee, in the facility with which calculations were made, and the increased simplicity of book-keeping; and, I will add, that I think this is the general view of the case."

After 17 years' experience of the working of the decimal system, a member of the Government Council (Hon. W. E. Sharpe) wrote:—

"I never heard of any—the slightest—hitch or trouble being experienced by any department or individual, public or private, official or native, in working the decimal system in Ceylon. It was quite marvellous to me to see, on my return there in 1873, that every one had fallen into the new system; and one's bazaar [marketing] accounts were as simple as they had before been complicated."

If this florin system were adopted, it would fall in well with the rupee of India, especially if the Indian rupee were divided into 100 cents, as is already done in Ceylon and Mauritius. The relative values in each country would still be affected by the varying rates of exchange; but it would be a great boon to all who trade with India to have the English and Indian coinage, as well as that of Ceylon, under one denomination; and, were this change effected, it is probable that our other dependencies would follow in the same direction. Advocates of Imperial Federation may like to go a step further, and have but one system of coinage throughout the whole British Empire; and, if this suggestion were acted upon, the florin and cents might be stamped with appropriate Indian as well as with English characters. India is now bound to us by ties so close, and the interchange of trade is so enormous, that this federationist view may be worth consideration.

As to the proposed new farthing representing 4 per cent. less than the existing farthing, the difficulty is really less serious than would at first sight appear. It is true that the primary object of coins is to facilitate payment, especially in retail transactions, rather than to serve mere calculations; but it is only in cases of single purchases of the value of one copper coin that difficulty in the altered value of the copper coins would be appreciably felt. Moreover, this would only occur when the change is first made, and my belief is that the actual inconvenience would be slight, and that the well-known tendency of trade to adjust its own operations would soon afford the relief required. See how this very difficulty was exaggerated by anticipation in Ceylon, and how easily the actual change was effected. It

is of course only fair and right that the interests of the poor, as well as of the richer classes, should be carefully considered; but all sections of the community should meet the difficulties of the case in a reasonable spirit of give and take, and then I feel sure that no more real trouble will be felt in this country than has actually occurred in other countries, where the people are no more practical minded than ourselves. Let us remember also that, thanks to the greater spread of education, there will be less difficulty on the score of understanding a new system than would have been the case some thirty years ago, when the last Royal Commission reported on the subject. As a matter of fact, when emigrants go to Canada and the United States, they learn the decimal coinage of those countries in a few days, and have no difficulty in understanding the equivalents of English money.

When several articles are bought or sold, and can be priced in groups, the difficulty as to payment can be readily adjusted, except in a few cases, when there may be a difference of about half a farthing. To prevent loss to the Government on penny postage stamps under the florin system, Colonel R. J. Ward proposes* that six stamps should be sold for 25 cents, and a single one for 5 cents. This principle is already applied to the sale of post-cards, which are sold at a price greater than $\frac{1}{2}$ d. each, but not at a price allowing an actual equivalent in cash for one card. As $\frac{1}{2}$ d. is too little for each card, ten are sold for 6d., but for a single card $\frac{3}{4}$ d. must be paid, this being at the rate of $7\frac{1}{2}$ d for ten. Again, in the Customs' tariff where the duty on an article is 3d. an ounce, it would not be a fair adjustment to charge either 12 or 13 cents, seeing that the duty would really be $12\frac{1}{2}$ cents, and Colonel Ward suggests that the duty should be calculated on the basis of 6d. for 2 ounces. Take, for instance, 16 ounces at 3d. = 48 pence or 4s., and 17 ounces at 3d. = 4s. 3d.; in the former case there is no difficulty in the conversion, and in the latter 2 florins 13 cents would be paid instead of 4s. 3d., the importer thus paying the State an excess of less than half a farthing. Even half-farthings multiplied would be objected to by merchants, but by adopting the plan proposed, the importer would only suffer a loss of less than half a farthing at most on the whole transaction, however large the consignment might be. In the case of the Railway Companies, it is well-

* "Decimal Currency based on current British coin."

known that they are empowered to charge 1d. a mile, and on the same principle as for the Customs' duties, it is suggested that the Companies should be authorised to charge on the basis of six miles for 25 cents. For a short journey of five miles, or for any fraction over four miles, they can now charge 5d. and would receive 21 cents, or the trifling excess of $\frac{1}{25}$ th of 5d. In a long journey, as from London to Edinburgh, where the distance is 399 $\frac{1}{2}$ miles, 400 pence, or £1 13s. 4d. can now be claimed; and for this the Company would receive £1 6fl. 67 c., or less than a farthing more than under the present system.

Primâ facie, the case of the penny and halfpenny newspapers presents the greatest difficulty of all, as there would be a loss of 4 per cent. on the sale of every paper sold singly by the publishers. But there are several ways in which this can be met. As a matter of fact, the publisher sells few single copies, and deals chiefly with agents and retailers, who are allowed a considerable trade discount, and a slight adjustment of this discount could be made. A very slight increase in the charges for advertisements—or what amounts to the same thing, a slight reduction in the space given for a certain price—could also be resorted to. The fact is that newspaper proprietors have greater difficulties than this to contend with, such, for instance, as the fluctuations in the price of paper; and with their well-known aptitude for business, the managers and publishers may be relied on to find means of shifting the burden to the community at large.

As to the keeping of accounts, if three columns are used instead of decimal points, as in Table H., and as in all present account-books, there should be no confusion whatever; and in speaking of florins and cents, it would greatly assist the mental process if the numbers under each denomination were treated as whole numbers. Thus we should say so many cents, and not so many hundredths of a florin; and again, so many florins, and not so many tenths of a pound. We should then have the resting-places for the mind which were advocated before the Royal Commission, in the same way as we now have with pence and shillings, and there would be fewer chances of error. As Lord Sherbrooke has told us, there is an old writing of Robert Recorde, in 1540, to the effect that we must “consyder how manye of that subtyler denomination doo make one of the grosser denomination.”

I have referred to several proposed systems

of decimal coinage, and there are others more or less ingenious which I could name, but on the present occasion I wish to avoid entering too closely into questions of detail; nor do I feel competent to deal with all the technical points relating to currency. I have endeavoured to give you in outline the general bearings of the coinage question, with a few touches here and there to assist you in following its intricacies, and I will now pass on to the consideration of

WEIGHTS AND MEASURES.

Great as is the need for a decimal system of coinage, it is even more important that our present unsystematised weights and measures should be simplified and decimalised. We are said to be a practical-minded people, and if this be true, it is difficult indeed to account for our submitting so long to lengthy and bewildering processes of calculating weights and measures such as we now use. In the Report of the Select Committee on Weights and Measures, presented in 1862, it is stated:—“For measures of length we have the ordinary inch, foot, and yard. We have, in cloth measure, yards, nails, and ells. There are four different sorts of ells. For nautical purposes, we have fathoms, knots, leagues, and geographical miles, differing from the common mile. . . . We have also the Scotch and Irish mile, and the Scotch and Irish acre. There are several sorts of acres in the United Kingdom, and there is a great variety of roods. We have, in almost every trade, measures of length specially used in those trades. . . . For measures of capacity, we have twenty different bushels: we can scarcely tell what the hogshead means. For ale, it is 54 gallons; for wine, 63. Pipes of wine vary in many ways. Each sort of wine seems to claim the privilege of a different sort of pipe. For measures of weight, we have about 10 different stones. . . . A hundredweight may mean 100 pounds, 112 pounds, or 120 pounds.”

Since then the “Weights and Measures Act, 1878,” makes it obligatory that the bushel shall contain 8 gallons, and that the gallon shall contain 10 pounds of distilled water at the temperature of 62° Fahr. This, however, has by no means got rid of conflicting values of the bushel measure, as the Secretary of the Nottinghamshire and Midland Merchants' and Traders' Association has just written that in Cornwall a bushel of potatoes is sold as 224 pounds, and in Nottingham as

only 84 pounds. He says, further, that in several places apples are quoted as 16 pounds to the peck; potatoes as 20 pounds; and pears as 18 pounds to the peck. In Worcestershire a pot equals 4 pecks; but in various other counties the pot varies from 64 pounds to 94 pounds. He adds:—"The large commission agents here are frequently puzzled as to the different weights and measures prevailing in other counties, and have to wire back before they understand how to sell the goods. The old Winchester bushel is still legal in the United States, and is occasionally used in this country for fixing corn-returns."

A dealer in iron, cement, soap, salt, coals, sugar, &c., must adopt the avoirdupois basis of tons, hundredweights, quarters, pounds, and ounces of 437½ grains each. A wholesale dealer in goods retailed by chemists buys by the pound avoirdupois, but sells by the pound troy, which consists of 12 ounces, of 480 grains each. We thus have the avoirdupois pound equal to 7,000 grains, while the troy pound is equal to 5,760 only of the same grains; and there is the anomaly, that the troy ounce is heavier, while its pound is lighter, than the avoirdupois. The troy pound, divided into ounces, pennyweights, and grains, is the standard at the Mint; but dealers in gold and silver bullion use the troy ounce, divided into 1,000 parts.

To these might be added a great number of other eccentricities, but it would serve no useful purpose to enumerate them. The fact must be patent to all, that we have to use a mass of inconsistent and incongruous tables, which cause needless worry and loss of time to all classes of the community, and especially to beginners, whose school time is so precious. If this country were isolated, and not dependent commercially on its dealings with foreign countries, its idiosyncrasies as to weights and measures might perhaps be treated as mere internal disorders. This, however, is by no means the case. In former times, English merchants, engineers, and manufacturers, undoubtedly had a much greater command over foreign markets than at present, and, to a certain extent, they could with impunity force their customers to base their calculations on English weights and measures. Such happy days are now of the past. During the last twenty years especially, all the leading European countries have enormously increased their powers of production, and they are not only striving to manufacture all required for their home consumption, but are energetically push-

ing the sale of their wares in other countries. English engineers and manufacturers are, in fact, in keen competition with those of other countries, and our Consuls have, in several instances, drawn attention to the loss of trade we sustain owing to the difficulty foreign dealers experience in understanding our language, our coinage, and our weights and measures. In confirmation of this, I may quote the following extract from the Foreign Office Report, No. 180, dated 1st August last, on subjects of general interest in Italy:—

"Manufacturers state that the exertions of German travellers to push their trade are indefatigable, and, as they are always anxious to comply with the desires of their customers, they are often successful, while British firms, instead of travellers, forward catalogues, which are of little or no use, especially as they are for the most part drawn up in English, and prices are quoted in English weights and measures."

A correspondent from Buenos Ayres writes that he was asked, by a shipper of wheat out there, how wheat was sold in England. He consulted a trade reference, which gave the weights of different bushels used in various parts of England, but the cargo was eventually sent to another country, because the shipper could not tell from the market quotations what the yield in money would be.

Another gentleman, who was for many years a smelter on the Pacific Coast, calls attention to the difficulty of making foreigners understand our system of reckoning the per-centages of metal in ores, &c.; and he writes, that "many a good shipment of ore or matte has gone to Freiberg, instead of to Swansea, because the owner wanted an account he could understand." He adds that, for this same reason, "the most influential mining organ in the United States, the *Engineering and Mining Journal of New York*, has always advised the shipment of ore to Germany instead of to England."

A very influential deputation, representing Chambers of Commerce, bankers, merchants, and others, was received by the Chancellor of the Exchequer in June, 1887, to urge the adoption of decimal coinage, weights, and measures; and, among the speakers, Mr. W. Crawford (delegate of the British Chamber of Commerce in Paris) said, "that after living in Paris for 25 years, as a merchant in English goods, he had been face to face with the practical side of the question, and he could testify to the great value of a purely decimal system. He had always to reduce the

complicated English system to the French one before he could sell any of his goods there. Manufacturers in England had done a great deal to bring the machinery of their factories to the highest pitch of productiveness, but they had done very little to improve the mental machinery by which they made up their costs and prices; and this should no longer be neglected in these days of keen competition." Another experienced merchant in Paris (Mr. Th. Pilter) complains of the great inconvenience he is put to in offering English machines to French buyers. Supposing, for instance, that he is asked to quote for an English implement, the price of which is £13 in London, and of which the gross weight is 4 cwts. 3 qrs. 8 lbs., and the nett weight 3 cwts. 2 qrs. 24 lbs. He must first convert the £13 into francs, and then the gross weight into 245 kilos for the transport charges, and the nett weight into 188 kilos for the duties. These calculations take time, and are liable to error; whereas, by the decimal system, it would be as follows:—

	Frs. C.
Price in London	325'00
Carriage on 243 kilos, at 5 frs.....	12'25
Duties on 188 kilos, at 5 frs.	9'40
Price delivered	346'65

In Europe, we are chiefly in competition with makers in Belgium, France, Germany, and Italy; and the metric system of weights and measures is not only used in all these countries, but also in nearly all those where the competing makers sell their goods. Suppose, for instance, that a manufacturer in Barcelona requires some new machinery for spinning, for dyeing, or for finishing. He will probably require detailed drawings and specifications to be submitted to him, and he will expect to have them based on the metric system which has been adopted in his country. On their part, the French, German, and Italian makers will also follow their usual metric scales for the drawings, and will specify the work to be done in terms of the metre; but if the English competitor follows his usual scales, and his usual weights and measures, the Spaniard will either not understand them, or must be at the trouble of converting them into metric equivalents, so as to compare them closely with those of the other competitors. Or the Englishman must prepare his drawings and calculations in a way he is not accustomed to. This, however, is not the only drawback, for as the negotiations proceed, various altera-

tions and details will have to be discussed, and the Englishman must be *au fait* with the metric system, not only to make himself clearly understood, but to prevent his entering into engagements he cannot profitably fulfil. Further than this, if an English machine is eventually ordered, the maker will probably have to send an English mechanic to erect it abroad, and the latter, in his turn, will be perplexed with the foreign weights and measures, and will have much difficulty in giving instructions as to the dimensions to be followed.

This is no unusual case, but is the everyday experience of all makers of machines, and of the merchants or agents who so often act as intermediaries. If we take the common case of a portable engine required for agricultural purposes, in any country where the metric system is used, the steam pressure, the horsepower, and the fuel consumption must all be expressed in terms of the metric system. So also with pumps, and an endless variety of the commonest machines. Again, if so simple a thing as a gas stove is required for heating or cooking, the consumption of gas, and the heat developed must be based on the metric system. Or, suppose a purchaser in Spain or Italy requires cement, he will naturally specify the weight in kilograms, and the tests to which the cement must be subjected will also be based on the metric system. The same with coals, iron, and many other natural and artificial substances, and the general result is that the merchant or manufacturer who competes with foreign sellers must either put himself at a disadvantage if he quotes in English weights or measures, or he must adopt the metric system in his calculations and in his contracts.

Some ill-informed persons imagine that our trade with the foreign countries, where the metric system is used, is not very great; but a reference to Table B will, I think, remove all doubt on this head. The statistics of imports and exports given in this Table are taken from the last published Board of Trade "Statistical Abstract" (No. 37, 1890), and may, therefore, be taken as trustworthy. Excluding British Possessions, the value of the total imports in 1889 was £330,371,524; of the total exports, £224,275,950; and of the total imports and exports, £554,647,474. The value of the imports from countries using the metric system was £189,298,970, or about 57 per cent. of the total imports. The value of the exports to countries using the metric system was £159,560,779, or about 71 per cent. of the

total exports; and the value of the imports to and exports from countries using the metric system was £348,862,574, or about 62½ per cent. of the total imports and exports. The Board of Trade returns do not include Bolivia, Bulgaria, Servia, and Switzerland; but all these countries use the metric system, and their populations of 2,300,000, 3,154,000, 2,096,043, and 2,933,334 respectively, or a total of 10,483,377, should be added to the total given in Table B. Facts such as these prove that the adoption of the metric weights and measures has spread considerably, and there is little doubt that it will continue to spread, whether we adopt them or not. In India the need for revising the weights and measures has long been felt, and as a result of careful investigations, and of the able advocacy of General Strachey, an Act was passed in 1871, which authorised the Governor-General in Council to sanction the use of new standards. The primary standard of weight was to be called a seer, and was to be a weight of metal equal to "the weight known in France as the *kilogramme des Archives*." The measure of capacity was to be a measure containing one such seer of water at its maximum density. General Strachey informs me that this system was approved by Lord Lawrence, and afterwards by his successor, Lord Mayo, also by Sir W. (afterwards Lord) Sandhurst, Sir H. Maine, Sir J. Strachey, Sir R. Temple, and Sir H. Norman. After the passing of the Act, the Railway Companies were preparing to adopt the new weights, in anticipation of their being adopted, and went so far as to alter their scales, &c.; but unfortunately the death of Lord Mayo intervened, and his successor, Lord Northbrook, did not take active steps to promote the use of the new standards, and as the Act was only permissive it became practically a dead letter. It is believed that the Government of India held back at the last moment, in expectation of a reform being made in the British weights and measures; but the fact remains that, after careful investigation, the metric unit was chosen, and it may be said that so far the way has been cleared for the general adoption of the metric system, when it has been adopted in England. There is also a reasonable probability that if the metric system were adopted here, it would also be taken up in Australia, Canada, and our other dependencies. There is a probability, also, that our example would be followed in the United States, but it is still more probable that the United States will set

us the example. There is a strong party in favour of the metric system in that country; and in speaking of the importance of adopting it for goods exported to Mexico and to Central and South America, an able writer in the *Engineering and Mining Journal* of New York, shrewdly remarks that the goods sent to these countries should be made in sizes and shapes the buyers are accustomed to, and he adds: "If we are going to contest with England the commercial control of this hemisphere, why should we not take advantage of her obstinacy, and, by suiting her customers, get them away from her?" Then, again, in Russia, there is a strong disposition to adopt the metric system, and this change would certainly be made if England were to join with other nations who have this system.

We see, therefore, that already over 60 per cent. of our foreign trade is with countries having the metric system, that India has been prepared for it, and that there is the further probability that the remaining great trading countries will adopt it whether we do or not. I think, therefore, that, on these grounds alone, I am justified in saying that we shall be injuring ourselves if we longer refuse the benefits which will accrue to us, if we adopt the simple and rational basis of weights and measures used by our foreign competitors and customers. It is, however, urged by some that, after all, our foreign trade is in the hands of comparatively few persons, and that the great bulk of our population has no concern with it, and need only look to its home requirements. I venture to say this is a narrow and wrong view to take, for are we not all interested, directly or indirectly, in the prosperity of our foreign trade, and in our being able to withstand the effect of competitors abroad? But even supposing this narrow view could be sustained, I would remind you that the whole nation is directly interested in the doing away with our absurd odds and ends of weights and measures, and in the simplifying of our arithmetic, to which I have already alluded. The metric system, as set forth in Table J (p. 221), is very easy to learn, and is essentially simple and consistent. Thus the unit of *length* is the metre, of *surface* the square metre, and of *volume* the cubic metre. Applied to liquids and grains, the measures of volume become measures of capacity, and the unit of *capacity* is the litre, which is the cube of one-tenth of a metre. Scientifically the unit of *weight* is the gramme, which is the weight of a cubic centimetre of water at its greatest density; but by

TABLE J.
METRIC WEIGHTS AND MEASURES.
MEASURES OF LENGTH.

		Equal to	
		Inches.	Feet.
METRE	Fundamental unit of weights and measures	39'3708	3'280
Decimetre	One tenth (.1) of a metre	3'9370	'328
Centimetre	One hundredth (.01) ,, ,,	'3937	'033
Millimetre	One thousandth (.001) ,, ,,	'0394	'003

(For long distances, a kilometre is used for 1,000 metres.)

MEASURES OF SURFACE.

		Equal to	
		Square feet.	Square yards.
SQUARE METRE.	100 square decimetres	10'7643	1'196
„ Decimetre.	100 „ centimetres	1'0764	'119
„ Centimetre.	100 „ millimetres	'1076	'012

(In measuring land, one are is used for 100 square metres, and one hectare for 100 ares, or 10,000 square metres.)

CUBIC, OR SOLID MEASURES.

		Equal to	
		Cubic feet.	
CUBIC METRE ..	1,000 cubic decimetres	35'316	
„ Decimetre ..	1,000 „ centimetres	3'531	
„ Centimetre..	1,000 „ millimetres	'353	

(The stère is in some cases used for one cubic metre.)

MEASURES OF CAPACITY.

		Equal to	
		Cubic inches.	Pints.
LITRE	1,000 cubic centimetres, or one cubic decimetre	61'027	1'760
Decilitre	100 „ „	6'103	'176
Centilitre	10 „ „	'610	'017
Millilitre	1 „ „	'061	'002

(The hectolitre is used for 100 litres. One cubic metre = 1,000 litres.)

WEIGHTS.

		Equal to	
		Grains.	
GRAM	Weight of one cubic centimetre of water at its greatest density	15'4323	
Decigram	One tenth (.1) of a gram	1'5432	
Centigram	One hundredth (.01) ,, ,,	'1543	
Milligram	One thousandth (.001) ,, ,,	'0154	

(The kilogram is used for 1,000 grams. One cubic decimetre or litre of water [at its greatest density] weighs one kilo, and one cubic metre or 1,000 litres of water weigh 1,000 kilos, or one ton.)

usage the kilogramme, which is the weight of a litre of water, is treated as the practical unit. All these units have simple relations to one another; thus a cubic metre contains 1,000 litres, and as one litre contains one kilogramme of water, so one cubic metre contains 1,000 kilogrammes, or one (metric) ton of water.

The specific gravity of a substance is its weight in relation to that of water, and as the weight of water contained in any metric measure of volume is known, it follows that the weight of any substance can be easily found, when its bulk in terms of the metre is known, by simply multiplying the latter into its specific

gravity. Or, if we know the weight of any substance, we can easily find its volume, by dividing the weight by the specific gravity. For instance, the weight of a boat load or store of corn, lime, or other substance can easily be ascertained by multiplying the length, breadth, and depth in metres by the specific gravity. The result, taken as kilogrammes, will be the weight. On French slide rules it is customary to give the specific gravity for common substances, such as wood, lead, iron, stone, for the purpose of making these every-day calculations.

Against the metric system it is urged that the metre is not strictly the ten-millionth part of a quadrant of the meridian passing through Paris, as it professes to be; that the metre is therefore an arbitrary unit; that it is impossible to weigh water at 4° C. (*i.e.*, when at its maximum density) in a vessel at 0° C., as the water must be at one temperature and the containing vessel at another; and, finally, that the weights are standardised in a vacuum. There is truth in all these assertions, but from the practical point of view what does it really matter, seeing that our Board of Trade Standards Department now possesses a complete set of metric standards of the highest scientific precision; that the metric system has already been adopted by all the countries enumerated in Table B; and that the remaining countries of first importance are contemplating its adoption.

Among scientific men the metric system is used invariably in *all* countries, and all who learn chemistry, physics, or any branch of science, in this or any other country, must almost of necessity use this system. In all text-books the metric system is adopted, and science teachers, whether in the university or in the technical schools, use it without exception. In the chemical manufacturing trades it is especially necessary that it should be in familiar use, if only for the purpose of following the records of what is being done by competitors on the Continent. It is nearly as important to metallurgists, and to all concerned in the treatment and purchase of foreign ores. Electricians throughout the world have adopted a system of electrical units based on the metric system, and telegraph and telephone wires are now gauged in millimetres. Artillerists, opticians, and most of those who use instruments of precision, and, in fact, nearly all those whose work depends on accurate measurement, and on improved scientific methods, now use the metric system almost of necessity, as it is not only the simplest and

best, but it is also the keynote to the technical teaching of the Continent. Photographers are now feeling the want of the metric system, as many of the formulæ for their solutions, &c., are given in metric weights and measures.

Many ingenious proposals have been made for decimalising some of our existing weights and measures; and, doubtless, some of them would greatly improve those now in use; but I entirely agree with the Select Committee of 1862 that "it would involve almost as much difficulty to create a special decimal system of our own, as simply to adopt the metric decimal system in common with other nations. And, if we did so create a special national system, we should, in all likelihood, have to change it again in a few years, as the commerce and intercourse between nations increased, into an international one."

By some it is feared that the difficulties to be overcome in changing our weights and measures render such a change impracticable; but I feel sure that these difficulties have been exaggerated. Before the present German empire was formed, there were different systems of coinage, weights, and measures in nearly all the States; but after the Franco-German War, a uniform decimal coinage and (regardless of national prejudice) the French metric weights and measures were adopted, the whole change being effected without serious difficulty in about four years. In all countries where the metric system has been adopted, the old systems previously in vogue were changed without great inconvenience, and in no one of these countries has it ever been proposed to give up the metric system, as its advantages have been so well appreciated. It only remains for me to refer to the composite Greek and Latin names used in connection with the metric system. I admit that this is a practical difficulty for English-speaking people, but it also has been exaggerated. The fact is, that for weights, the *gram* and *kilogram* are the terms used for ordinary purposes, and the *millimetre*, *centimetre*, *metre*, and *kilometre* for measures of length, while *square* and *cubic metres* are generally used for superficial and solid measure, and the *litre* and *decilitre* for measures of capacity. When the late Mr. Beresford Hope tried to defeat the Metric System Bill in the House of Commons, he poured scorn on its nomenclature by saying—"Only imagine an honest housewife going into a shop and asking for a decigram of pepper and a decagram of tea; imagine, too, the milkmaid selling her fluid by the litre. Fancy

the bumpkin who was prepared to boast that he was within a decimetre of catching the fox as he crept through a gap about a decametre from the white gate." This was doubtless a mere trick of rhetoric, for the speaker must must have known that, in the ordinary affairs of life, no one would want to buy the tenthth part of a gram of pepper, or of any other commodity. The term decagram is not used, and the purchaser should ask for ten grams of tea, which is just as simple as ten ounces. There is no serious objection to selling milk by the litre, but the term quart might be retained if the value of a litre were given to it. As for the bumpkin, he might easily substitute the term "hand" for decimetre, or whatever simple term might eventually be adopted, and instead of saying decametre (an unusual expression), he should simply say ten metres, or ten yards, if the value of a metre were given to a yard. It is no doubt remarkable that so many of the names for weights and measures are monosyllabic, such as inch, foot, yard, mile, pint, quart, peck, ounce, pound, ton; but it is questionable whether old familiar names should be retained under another system, with new values. The Dutch tried this, but it led to so much confusion that the French names were eventually adopted.

CONCLUSION.

The time at my disposal will not admit of my entering into further detail, but I have endeavoured to lay before you briefly the leading facts and arguments in the light of our present requirements, and I trust you will agree with me that there is pressing need for a thorough investigation of the whole subject by a Royal Commission. I do not ask any one to pledge himself to any particular system, and I have no fads of my own to put forward; but from an entirely independent standpoint I do beg of you, one and all, to press for a full and comprehensive inquiry. As evidence of the opinion of important bodies of commercial men on the subject, I may mention that all the seventy-two Chambers of Commerce of the Association of the United Kingdom have repeatedly pronounced themselves in favour of the decimal system, and the four large Chambers which are not members of the Association (Edinburgh, Glasgow, Liverpool, and Manchester) have taken the same ground. At the last meeting in March, 1890, the Association resolved "that a deputation be appointed to wait upon the Vice-President of the Committee of Council for Education, to urge that steps

may at once be taken to make the study of the decimal system of coinage and weights and measures a compulsory subject in all public elementary schools." Effect was given to this on June 16th, when an influential deputation waited on Sir W. Hart-Dyke, who acknowledged the importance of the body which the deputation represented, and of the subject under consideration. He said that he had long been in favour of such a system, and that they had his most cordial sympathy as far as the general policy was concerned. He thought his Department would not be able to carry out the suggestions of the delegates before the system was legally authorised, but that, bearing in mind that the education given to the children must not only be the best, but the one most immediately suitable to their welfare, progress, and success in life, he would be glad if in the future he was enabled in any degree to forward the objects the deputation had in view.

I could give many quotations from public speakers in favour of the decimal system, but, having laid the case before you, I prefer to leave you to judge for yourselves on its merits, whether or not it is one deserving of the immediate attention of the Government. Since the time of the Great Exhibition of 1851, when the jurors were embarrassed by the various weights and measures used by the exhibitors from different countries, the Society of Arts has taken an active part in advocating the adoption of a decimal system; and now that there is greater need than ever for such a change, I feel sure that my appeal to Members of this Society will not be in vain. Thanks to the persevering action of Mr. Samuel Montagu, M.P., who for years has advocated the change in question, the Decimal Association has now been re-established, and I know that its members will heartily welcome your co-operation.

DISCUSSION.

The CHAIRMAN said he was sure this paper would receive the cordial attention of the meeting. The English were not only a conservative but a long suffering people, or they would not have endured for so long the horrible system of weights, measures, and coinage which had been so graphically described. The educational argument appeared to him to be extremely strong, and he was glad to have been one of the deputation which, in June last, waited on the Vice-President of the Council to urge him to do what he could to remedy this condition of things.

He had benefited largely himself from the use of the metric system, which was employed of necessity by scientific men in all countries. He had also seen the simplicity and ease with which arithmetic was taught in foreign schools, and could bear testimony to the way in which the old German system of weights and measures was entirely swept away in a few months, when the new system became the law of the land, and how readily it was adopted by the people. Sir H. Trueman Wood had just reminded him of the difficulty he had in conducting the business of the last Paris Exhibition in translating square feet and £ s. d. into square metres and francs, and that was but one instance amongst hundreds which were constantly occurring. Mr. Goschen told Mr. Leng, in answer to the memorial sent from the Dundee Chamber of Commerce, that he was well aware of the strong case which the advocates of a decimal system had made out, but the difficulties were very great, and he could not undertake to bring in a Bill. They did not expect him to do so at present; the matter required further consideration; for although several Committees and Royal Commissions had sat upon it, the whole question was not then considered, and they wanted a new Royal Commission to consider the whole subject. He could not help thinking that if pressure were brought to bear on the Government by Chambers of Commerce, and by all interested in the simplification of the present confusion, not only would a Commission be granted, but the public would be ripe for a decisive step being taken that would put us on a level with all the rest of the civilised world.

Mr. SAMUEL MONTAGU, M.P., said he marvelled to find how much fresh matter Mr. Dowson had to say on a subject which had been so often discussed before. His coloured map of the world, in particular, was a most ingenious and effective object-lesson which he had never seen before. He had asked for a Royal Commission, year after year, in vain, but now that Sir Henry Roscoe and others were supporting him he hoped more impression would be made. The duty of such a Commission would be, in the first place, to consider whether the decimal system was superior to the present one—and on that point he did not fear the result—and then to decide what particular system should be adopted. Personally he was in favour of a system which would retain most of the existing coins, and of adopting the metric system bodily for weights and measures; but he would not press his own view, and would adopt any system of decimals rather than the present confusion. It would be the duty of the Commission to take evidence, and then decide on which was the best system. His colleagues of the Decimal Association and of the London Chamber of Commerce, which took this matter up a few years ago in a very hearty manner, and led to the re-establishment of the Decimal Association, agreed in not advocating any particular unit. It

might be asked, what better hopes of success were there now than there were thirty years ago, when he took part in the agitation in which Professor De Morgan was so prominent? But the answer was threefold. At that time, many of the great powers of Europe had not adopted the decimal system. Prussia, Saxony, and Hamburg all had different coins; but now all Germany had the mark and the pfennig. Norway, Denmark, and Sweden also had their own systems; now they all had the krone and 100 öre. Mr. Dowson had not even made his map as complete as it might be, for he had omitted Alaska; but whether it belonged to Russia or America, it had a decimal coinage. Persia also used decimals for money on account, and was about to adopt decimal coins, in place of the multifarious currency now in use. In some parts they had adopted the rupee, divided into tenths. The second reason was, that since 1870 we had had compulsory education; and it was a great responsibility to compel the children of the working classes to undertake complex studies, which would be quite unnecessary under a better system, and, in the saving of time to the children, would mean a saving of school rates to the public. Thirdly, in consequence of the Education Act, the people were more intelligent, and would be better able to master the change in a short time. When emigrants went to Canada or the States, they very soon learned to understand dollars and cents., and they would do so just as readily at home. Last month, when in Paris making purchases at the Louvre, he noticed how rapidly the clerk made out a long account as easily as if there were no calculation at all involved, and he had often remarked how much superior foreigners were to Englishmen in this respect. In his own banking house they had to telegraph every few minutes, and for convenience they always translated the English prices into decimals, and when they got the reply, turned the figure back again into pounds, shillings, and pence. He had received 154 petitions, containing many thousand signatures, on this subject, all obtained without the aid of any paid canvassers; and when they were presented, and the case was supported by a hundred or two Members of Parliament, he thought they might make some impression on the Chancellor of the Exchequer.

Mr. J. BIDDULPH MARTIN said it had been remarked that if the building of Noah's ark had been referred to a Royal Commission, nothing would ever have been done; and he had an impression that Lord Overstone's Commission in 1853 was not very encouraging to the advocates of a decimal system. He would not discuss the educational side of the question, but with regard to matters of everyday practice, the array of figures on the Tables was certainly very impressive. He would remind the meeting, however, that 1d. was not the exact decimal of $\text{£}1$, and therefore it would be necessary either to scale up the $\text{£}1$, or to scale down the penny; and even in the farthing there was an appreciable difference between $\frac{1}{40}$ and

$\frac{1}{1000}$. It had been said that these decimals did not prevent the occasional use of vulgar fractions, and that was found to be so in practice; in Exchange operations the decimal system broke down at certain points; it was very common to make a quotation in American dollars, plus or minus $\frac{1}{16}$ th; the working of that out in decimals would be too cumbersome. The arithmetical machine of Mr. Thomas he had in constant use, and it was used by many others, as well as Mr. Tait's and other aids of the same description, but it was subject to the drawback that in English currency you never got to an exact figure. No doubt the state of affairs with regard to weights and measures was most anomalous, but the adoption of a decimal system would not remove all the anomalies. In Cheshire alone there were eleven kinds of acre recognised, and although some years ago a Weights and Measures Act was passed, it had not produced uniformity. Even in Paris the people still reckoned in sous, and in Switzerland the measurement of land was by the *toise*, and various other archaic measures were still in use. Nevertheless there were indisputable advantages in the decimal system, and when these had been made clearly evident, by universal adoption in ordinary life, it would be time to give them the sanction of legislation.

Sir GUILDFORD MOLESWORTH, K.C.I.E., said the objectors to the decimal system picked out one or two objections, and did not set against them the manifold advantages, which would be found to greatly counterbalance them. He had been in many countries where a decimal system existed, France, Italy, Portugal, Ceylon, the Straits Settlements, China, Japan, and California, and never found or heard of the practical difficulties which were supposed to exist. He had a struggle for some years to introduce the decimal system into Ceylon, the whole of the Council being at first against him, but he persevered until he succeeded, and no difficulty whatever was experienced in the practical working of it. He had a great deal to do with the suggestions for altering the stamps, tolls, accounts of the department, and so on, but his financial secretary wrote to him, six weeks after the introduction of the decimal coinage, saying the necessary changes had been effected without the slightest hitch or difficulty of any kind; and in fact it was so little felt that people had already ceased to talk about it. Seventeen years afterwards he wrote to one of his colleagues, the Hon. W. E. Sharp, to ask what was the feeling in the colony about it, and he also said there had never been the slightest trouble, either on the part of the department or of any individual; that it was marvellous how everyone had fallen into the new system. In order to use calculating-machines, the figures dealt with must be translated into decimals and back again. They were very useful indeed, and he frequently availed himself of them. In China, people used the decimal system without any education whatever, and by means of the abacus made their calculations very

rapidly. A great deal of the objection raised by Lord Overstone's Committee was directed to a change in the currency while the present complicated system of weights and measures remained unchanged. The use of the word "sou," was simply an instance of retaining the old word for the new coin; it said nothing against the system.

Mr. H. SIMON (Manchester) said he was educated in Switzerland, where the French system existed in its entirety; and having been there when it was introduced, he could say that no difficulty was experienced at all. He could not understand the decimal system breaking down at $\frac{1}{16}$ ths; and certainly in France, Italy, Germany, or Switzerland, he should be at a loss to know where the $\frac{1}{16}$ th came in. He might add, that last week the Manchester School Board had determined to join in the petition to Government.

Mr. ALFRED CARPMAEL said that some time ago he heard a lecture at the Royal Institution by Sir Frederick Bramwell on precisely the opposite lines; and he was more convinced by that than he was to night. Many of the arguments adduced by Mr. Dowson were not so much in favour of the decimal system as in favour of uniformity. He referred to the various measures in use throughout the country, and said, that if the decimal system were introduced, all these difficulties would disappear. It might be so, but that had not been the result of previous laws for the unification of weights and measures. It was of course in legal contracts, but not in every-day life. Then he said a Consul wrote:—"We cannot understand your language, your weights and measures, or your money." Were they to change all three? and how much of the difficulty was due to each; was not the language probably the most important difficulty? Then, if they were to start afresh, would it not be better to have a shilling which could be divided by four numbers than one which could only be divided by two, viz., by 2 and 5, whereas a shilling of 12d. could be divided by 2, 3, 4, and 6, and gave results which might be again sub-divided. The onus of proof lay on those who wished a change. As Sir Frederick Bramwell said, the decimal system did not produce a specific impression on the mind; you had a distinct notion of what a sixth of a thing was or even a thirteenth, but who could appreciate the idea of $\cdot 166$ or $\cdot 17614$. The paper was a most able and interesting one, and perhaps when he had had more time to study it he might be converted; but if it were true, as he had heard, that you could not find a book on any subject in which the decimal system was used without finding errors in the placing of the decimal point, he thought it would be wise to wait a good while before making the change.

Colonel ROBSON (chairman of the Sunderland Chamber of Commerce) said he went to school in

France, and could say, from experience, that the teaching of arithmetic there was mere child's play; so much so, that the professors had time left to give illustrations of the English system and various others in vulgar fractions, as obsolete curiosities. He did not see the use of any more Royal Commissions; they wanted to get the matter into some practical shape. It would be a matter of very great difficulty to effect a complete revolution throughout the country, because the Government was not despotic, and therefore he thought the change should be a gradual one, and that the simplest way to begin would be with the coinage; that would not even require an Act of Parliament, as it came within the Royal prerogative. It could be effected without altering any existing coin except the bronze ones; all the silver coins, with the exception of the four-shilling piece, would be decimal parts of the unit, whether that unit were the sovereign or the florin. There had been various discussions as to the unit, and it was very desirable that some agreement should be come to on this point. The only units seriously mentioned were the pound, the dollar, and the florin. He objected to the pound on the ground that it would require in so many sums the calculation of three places of decimals. A pound of sugar at $2\frac{1}{2}$ d. would be '003, and that would be an objection, as the misplacement of a point would introduce such serious mistakes. A smaller unit was therefore preferable. He was once inclined to recommend the dollar, which might be divided into 100 cents or halfpennies, and would require no further points; but it had the disadvantage that, until recently, it formed no part of the present coinage, whilst the florin had been longer in use, and was therefore preferable. In almost all European countries the unit was kept low. In altering the system of weights and measures, there were so many difficulties in the way of retaining any of the present ones, that he should be inclined to go in at once for the metric system. There was not the same reason for adopting the French system of coinage, because, whatever was the nominal value, there would always be the question of the rate of exchange.

Mr. PAGLIARDINI said the tables of figures were more convincing than the most eloquent speech. A hundred years ago the decimal system began in a corner of Europe, and it had now spread all over the world with the exception of England and some of her dependencies. When this system was introduced, there was only one difficulty in arithmetic, and that was the multiplication table. He was educated in France, and began when the old system was in use, having been brought in with the Restoration, and he was perfectly disgusted with arithmetic; but in 1840 the decimal system was restored, and then he found not the least difficulty. No one there would say that the English were less intelligent than Italians, Swiss, Spaniards,

or any other nation, all of whom had adopted the decimal system without difficulty. He remembered travelling in Italy before the change took place, when sometimes you found four changes of coin in a day's journey, on all of which there was a loss. A few years after, he found the new system introduced, and no difficulty whatever was experienced. Many people did not seem to be aware that an Act was actually passed legalising decimal weights and measures in Great Britain and Ireland; but, somehow or other, in Committee some of its opponents managed to strike out the clause allowing the Warden of the Standards to stamp the Standards; and thus it became a dead letter.

Mr. DOWSON, in reply, said he thought Mr. Biddulph Martin's fear that our present weights and measures would still be used, even if others were legalised, had been answered very effectively by Sir G. Molesworth and Mr. Simon. From all he had been able to ascertain, there was very little difficulty experienced anywhere in making the change. When it was introduced in Italy the people were not by any means so well educated as the English of to-day, and yet, as they had just heard, no difficulty was experienced. He did not say it should be done hurriedly; a certain amount of time must be given. The case of Ceylon was a very apt one, and very instructive. He quite agreed with Mr. Martin that, in certain cases, vulgar fractions were superior to decimals, and should be used when required. But decimals were best for general purposes. Mr. Carpmel admitted that there was a terrible want of uniformity, but seemed to think it could be met by changing or reforming the present weights. The trouble of doing so would be quite as great as introducing the metric system, which would inevitably have to follow some day, in order that we might be on an equality with other nations. He had quoted a recent report from one of our Consuls abroad, but other authorities could have been quoted also, had time permitted. The real difficulty was not so much that of language, as of foreigners not understanding our prices and measures in quotations and circulars. As to the saving of time and trouble with a decimal coinage, he thought the argument presented in the tables was unanswerable. He did not profess to be a sufficient judge of currency questions to say which system of coinage was best, and it was not necessary at the moment to decide whether the coinage or weights and measures should first be dealt with; but the latter could probably be changed with the greatest ease, and with less delay.

The CHAIRMAN then proposed a vote of thanks to Mr. Dowson, which was carried unanimously, and terminated the proceedings.

Miscellaneous.

EXHIBITION OF EARTHENWARE AT BUDAPESTH.

Information has been received from the Foreign Office, through the Department of Science and Art, respecting an Industrial Exhibition and Market of Earthenware, Asphalt, Stone and Cement Articles to be held at Budapesth from 15th May to 30th June. Foreign exhibitors are invited to participate to a certain extent. Foreign firms will be admitted to exhibit machines, auxiliary methods, and implements. The Minister of Commerce subsequently agreed that the admission of foreign exhibits should be extended, to include articles of industry which have not hitherto been produced in Hungary. The costs of transport will be reduced to 50 per cent. of the freight expenses; and the Minister of Commerce has expressed his intention of purchasing practical machines and implements which are adapted to local requirements, or to facilitate their purchase by advances from State funds. The Directorate of the Commercial Museum at Budapesth, who are arranging the Exhibition, are prepared to purchase foreign articles of industry which may serve as patterns. In pottery, the Directorate desire to receive as complete collections as possible of products which may form a specialty of the country, or of a certain district. They consider that these products will find a remunerative market. Forms of applications for space must be filled up and sent in by the 1st of March. Her Majesty's Consul-General at Budapesth suggests in his despatch that, in order to avoid rejection of exhibits, it would be advisable for intending exhibitors to inquire of the Commercial Museum at Budapesth if the articles they propose to send would be admitted to the Exhibition. A few copies of the Regulations have been received, and any intending exhibitors can obtain a copy on application by letter to the Secretary of the Society of Arts.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

FEBRUARY 11.—SIR ROPER LETHBRIDGE, M.P., "The Proposed Irish Channel Tunnel." The DUKE OF ABERCORN, C.B., Vice-President, will preside.

FEBRUARY 18.—COL. SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S. "Methods and Processes of the Ordnance Survey." The ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

FEBRUARY 25.—E. J. RAVENSTEIN, "Colonisation and its Limitations." Sir RAWSON RAWSON, K.C.M.G., will preside.

MARCH 4.—J. HARRISON CARTER, "Modern Flour Milling." SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, will preside.

MARCH 11.—H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D., "Electricity in relation to the Human Body." W. H. PREECE, F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock:—

FEBRUARY 17.—COMMANDER V. LOVETT CAMERON, C.B., "Chartered Companies in Africa."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

FEBRUARY 26.—ROBERT GORDON, M.Inst.C.E., "The Economic Development of Siam." SIR CHARLES EDWARD BERNARD, K.C.S.I., will preside.

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. the LORD REAY, G.C.S.I., G.C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 10.—HEYWOOD SUMNER, "Sgraffito." CHARLES BARRY, F.R.I.B.A., will preside.

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, F.S.A., "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

POPULAR AFTERNOON LECTURES.

Friday afternoons, at half-past 4 o'clock:—
Captain ABNEY, C.B., D.C.L., F.R.S., "The Science of Colour."

February 13, 20, 27; March 6, 13.

CANTOR LECTURES.

The following Course of Cantor Lectures will be delivered on Monday evenings at Eight o'clock:—

A. J. HIPKINS, F.S.A., "The Construction and Capabilities of Musical Instruments." Three lectures.

LECTURE III.—FEB. 9.—Instruments grouped by the adaptation of a Keyboard—Its service to composition—History of the Keyboard—The early Organ—The Drone—Drawings of early portable Organ Keyboards—The Cantigas de Santa Maria—Keyboards in Italian and Flemish paintings—Summary of early large Church Organs from Praetorius—The long measure bass—The short measure or short octave—The mixture—Its dissection into registers—The pedal Keyboard—Sketch of a complete Organ—The Regal—The Harmonium and American Organ—The Ecliquier and the precursors of the Piano—The Pianoforte.

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

LECTURE I.—FEB. 16.—Importance of Transmission generally—Distinction between Live Power and Stored Power—Stored Power transmitted by Electricity and Air under pressure—Comparison between various ways of transmitting Stored Power—Cost of transmitting by Battery and Electromotor—Application to Trams.

LECTURE II.—FEB. 23.—Transmitting Live Power—Fundamental Principles—The Dynamo and Electromotor—Regulating Appliances—The Line—Best section of Conductor—Cost of Plant and Working Expenses—Examples.

LECTURE III.—MARCH 2.—Limit of Distance to direct Current Transmission—Alternating Current Transmission—Synchronising Motors—Ferrari's Motors—Motors for Small Powers—Electric Machine Tools.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 9. SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. J. Hipkins, "The Construction and Capabilities of Musical Instruments." (Lecture III.)

Sanitary Institute, 4A, Margaret-street, W., 8 p.m. Prof. H. Robinson, "Drainage."

Lantern Society, 20, Hanover-square, W., 8 p.m. Mr. J. Traill Taylor, "Lenses and Condensers for Lantern Work."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. G. Ravenstein "Messrs. Jackson and Gedge's Journey *via* Masa; Land to Uganda."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Henry Power, "The Brain: Its Functions and Structure."

TUESDAY, FEB. 10. SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Heywood Sumner, "Sgraffito."

Royal Institution, Albemarle-street, W., 5 p.m. Prof. V. Horsley, "The Structure and Functions of the Nervous System." (Lecture III.) "The Spinal Cord and Ganglia."

Medical and Chirurgical, 20, Hanover square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Messrs. Lewellyn B. and Claude W. Atkinson's paper, "Electric Mining-machinery."

Society of Architects, St. James's-hall, Piccadilly, W., 7½ p.m.

Photographic, Great Russell-street, W.C., 8 p.m. Annual Meeting.

Anthropological, 3, Hanover-square, W., 8½ p.m.

1. Mr. G. M. Atkinson, "Exhibition of Sketches of Horse Ornaments." 2. Mr. Sidney H. Ray, "Note on the People and Languages of New Ireland and Admiralty Islands." (From Letters of the Rev. R. H. Rickard.) 3. Cte A. Mahé de la Bourdonnais, "Note on the Presence of a Mongoloid Element in Brittany."

Colonial Institute, Whitehall Rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. The Earl of Aberdeen, "Canada."

WEDNESDAY, FEB. 11. SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Roper Lethbridge, "The Proposed Irish Channel Tunnel."

Sanitary Institute, 9, Conduit-street, W., 8 p.m. Mr. Louis Parkes, "Model Dwellings in London, and Overcrowding on Space."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Entomological, 11, Chandos-street, W., 7 p.m.

Shelley, University College, Gower-street, W.C., 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, FEB. 12. Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m.

Mr. J. Scott Keltic, "The Partition of Africa."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. Todhunter, "An Unknown Painter."

Royal Institution, Albemarle-street, W., 3 p.m.

Prof. C. Hubert H. Parry, "The position of Lulli, Purcell, and Scarlatti in the History of Opera." With Musical Illustrations. (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Major-General C. E. Webber's paper, "The Distribution of Electricity, with especial reference to the Chelsea System."

Mathematical, 22, Albemarle-street, W., 8 p.m.

United Service Inst., Whitehall-yard, S.W., 3 p.m.

Lieut.-Colonel N. L. Walford, "The Development of Field Artillery Material."

FRIDAY, FEB. 13. SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. Captain Abney, "The Science of Colour." (Lecture I.)

Royal Institution, Albemarle-street, W., 8 p.m.

Weekly Meeting, 9 p.m. Prof. A. Schuster, "Some Results of Recent Eclipse Expeditions."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. W. Herbert Wheeler, "The Cleaning and Deepening of Rivers and Canals by Means of the Transporting Power of Water."

Astronomical, Burlington-house, W., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m.

Paper on "Sanitary Building Construction."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Discussion of Prof. Minchin's paper on "Photo-Electricity." 2. Sir John Conroy, "The change in the Absorption System of Cobalt Glass, produced by Heat."

SATURDAY, FEB. 14. Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "The Forces of Cohesion." (Lecture I.)

Journal of the Society of Arts.

No. 1,995. VOL. XXXIX.

FRIDAY, FEBRUARY 13, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third and concluding lecture of the course on "The Construction and Capabilities of Musical Instruments," by Mr. A. J. HIPKINS, F.S.A., was delivered on Monday evening, 9th inst.

Mr. Hipkins played on the clavichord and harpsichord in illustration of the subject of the lecture. Mr. Herbert Bowman lent a clavichord; Messrs. John Broadwood and Sons, a harpsichord, a spinet, parts of piano, and model of action; Messrs. S. and P. Erard, model of action; and Messrs. W. Hill and Son, specimens of organ pipes.

A vote of thanks was accorded to the lecturer for his interesting course of lectures, on the motion of the CHAIRMAN.

The lectures will be printed in the *Journal* during the summer recess.

POPULAR AFTERNOON LECTURES.

The Council have arranged for a course of five popular lectures to be given by CAPTAIN W. DE W. ABNEY, C.B., D.C.L., F.R.S., commencing to-day, Friday, at half-past four o'clock, and continued on the following Fridays—February 20, 27, March 6, 13. The subject will be "The Science of Colour." The lectures will be of a popular and elementary character, and will be fully illustrated by experiments.

The regulations for admission will be the same as for the Cantor Lectures, each member having the privilege of admitting one friend.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, February 10th, 1891; CHARLES BARRY, F.R.I.B.A., in the chair.

The paper read was—

SGRAFFITO.

By HEYWOOD SUMNER.

The Italian words *graffiato*, *sgraffiato*, or *sgraffito* mean "scratched;" and scratched work is the most ancient form of graphic expression and surface decoration used by man.

The term "sgraffito" is, however, specially used for decoration scratched or incised upon plaster or potter's clay while still soft; and for beauty of effect, depends either solely upon lines thus incised, according to design, with the resulting contrast of surfaces, or partly upon such lines and contrast, and partly upon an undercoat of colour revealed by the incisions; while, again, the means at disposal may be increased by varying the colours of the undercoat in accordance with the scheme of design.

Now, it would be a curious and an interesting piece of research to trace this simple form of craft, from the rude but graphic scratchings of primitive man, down to the present custom of scratching mock stone joints on stuccoed walls, but such a review would be quite beyond my scope, and would belong rather to archæology than to art. My present purpose is to approach sgraffito from the craftsman's point of view, and to record my experience of that branch of sgraffito work which deals with plastered wall surfaces. With this end in view, I shall first try to explain the method—making precept visible in practice upon this duly prepared panel—then to mention some possible and preventible causes of failure in the work; and, finally, to say a few words respecting the manner of design which seems to be permitted or suggested by the method under consideration.

First, then, the method.

Let us suppose the surface intended to be treated is an inside bare brick wall. Rake and sweep out the mortar joints thoroughly, so that there may be no mortar dust lying in the raked out joints to weaken the adherence of the coarse coat to the sides of the bricks, then

give the wall as much water as it will drink. If you do not thoroughly satisfy the suction of the wall, it will absorb the moisture from the coarse coat, and consequently the cement will not have sufficient water to enable it to revert to its stone-like nature by process of crystallisation. It will not set, but merely dry, in which case it will be worth little more than dried mud.

Special care should be taken that the cement and sand,* which compose the coarse stuff, should be thoroughly mixed, otherwise its strength will be unequal—in one place there will be too much sand, in another too much Portland; possibly shrinkage cracks will result, and certainly you will not obtain what you require—an even suction for your finishing coats. Special care should also be taken that the surface of the coarse coat should be well roughened or friezed up, so as to give what is called a good “key.” This coat should be got on some days before you begin your work, so that it may have time to set thoroughly.

Supposing this to have been done, you will then space out the wall according to your scheme of decoration, and, having decided where to begin operations, give the wall in such place as much water as it will drink: then the colour coat should be laid, observing just the same precautions as to thoroughly mixing cement, sand, and colour,† and as to leaving plenty of key upon the finished surface.

You should calculate how much surface of colour coat it may be advisable to get on to the wall, as it is better to maintain throughout the work the same duration of time between the laying of the colour coat and the following on with the final surface coat: for this reason, that if the colour sets hard before you lay the final coat, you will never be able to get up the colour to its full strength wherever it may be revealed in the scratching of your decoration.

When the colour coat is quite steady and firm, and all shine has passed from its surface,

follow on with the final coat,* only laying as much as may be finished in a day's work; and when this has been trowelled up to your satisfaction, and has “gone off” properly, you can get to work upon your ground and should scratch your decoration as quick as you can before the plaster has time to set.

In cleaning up the ground of colour which may be exposed, care should be taken to obtain a similar quality of surface all through the work, by which means you will get a broad effect of deliberate and calculated contrast between the trowelled surface of the final coat and the scraped surface of the colour coat.

Thus far precept. And now in turning to practice, I am confronted by the same difficulty as met the clowns in “Midsummer Night's Dream,” when they wished to bring in a wall. “Some man or other must present wall,” says Bottom; “and let him have some plaster, or some loam, or some rough-cast about him, to signify wall.” Somewhat in the same spirit I have to tell you that this panel, covered with rough-cast and plaster, has been treated in the manner I have been describing, and it is thus that I present wall.

(Here followed a demonstration, in which a method of polychrome sgraffito was shown and explained.)

While speaking of method I should like to call attention to the great methodical success of the experiments in sgraffito made at South Kensington Museum some twenty years ago, under Mr. Moody. Both at the Science Schools and at the Music Schools the work seems to stand perfectly; and surely such achievements as these, and the many works executed under the skilful guidance of Mr. G. T. Robinson, are sufficient witness that the method is practical, notwithstanding the changes of our climate and the mischances of fog and smoke.

I now turn to the second part of my task, namely, the mention of some possible but preventible causes of failure in sgraffito work.

Sometimes we find a perfectly sound method falls into bad repute, owing to some condition or precaution having been neglected which should have been observed as a matter of course, had there been a tradition of craft experience in custom. For example, I was told only the other day, “What a pity that Gambier Parry's spirit-fresco method does not stand in

* Gauge of coarse coat: 1 of Portland to 3 of sharp, coarse sand.

† Gauge of colour coat: 1 of old Portland, 1 of sifted silver sand, 1 of powder distemper colour; Indian red, Turkey red, ochre, umber, lime blue, lime blue and ochre for green, oxide of manganese for black, may all be depended on. In using lime blue, its violet hue may be overcome by adding a little ochre to your gauge; it may also be noted that it sets much quicker and harder than the other colours named—a point to be remembered in making your calculations.

* For gauge of final coat—inside work: parian, airslaked for twenty-four hours, to retard its setting; or Aberthaw lime and Selenitic, sifted through a fine sieve. For outdoor work: Selenitic and silver sand, sifted as above.

our climate." The reason given for this statement being that a certain fresco executed in this method showed signs of decay. So it did; but the reason of the failure was that an overflow of rainwater had been trickling down the outside wall behind the painting, owing to the stoppage of a carelessly placed pipe, a mischance that certainly might have been avoided by that common-sense foresight which is bred of a sound, methodical custom. So in sgraffito work there is no popular craft tradition to avert chances of failure owing to damp walls, and, consequently, the reputation of the method suffers. I believe there is no method of wall decoration that will stand, unless you first make sure of a dry wall.

An inside wall is damp either because the pointing is defective, or because the material of which it is built is porous, or because the rain is not properly carried from the roof to the ground, or because there is a body of damp earth against some portion of the wall.

To re-point with Portland cement is a simple matter, but a wall built of porous material should always be looked upon with suspicion. Where practicable, the best thing to be done is to build a four-inch brick wall inside, in front of the damp wall, leaving a space for ventilation between the two walls.

Professor Church tells me that he has applied a silicate wash to porous stone, and has obtained successful results thereby; or, again, the difficulty may be met by an outside coat of stucco.

As to the danger of which I have already spoken, namely, the arrangement of the rain-water pipes, each case must suggest its own remedy; the main object in all, however, being to prevent the chance of an overflow running down the outside of your decorated wall.

If you are troubled by ground damp, it should be remembered that moisture arises more from the earth against the walls than from that beneath the foundations, consequently a damp course should always be placed above the top level of the ground line. Where possible, it is better that the earth should be cleared away, say, two feet from the wall, down to below the level of the footings, and then such trench filled in with concrete or stones; if with the latter, the drainage should be properly provided for.

Care should be taken in using Portland cement that it should not be quite fresh from the kiln, in which case a certain shrinkage

may attend its setting, and cracks appear on the work. Specially may this be the case if the wall surface which you are plastering should be uneven, and your coarse coat consequently vary in thickness. It is perhaps well to add that you should only get cement from the best makers.

Imperfect adherence of the coarse coat to the wall arises either from not properly cleaning out the mortar joints or from not giving the wall sufficient water, or, in the case of an uneven wall, and consequently a coarse coat of increased thickness, from the stuff "bagging"—that is, being forced from the wall by pressure from above. Such a defect may always be found out by sounding the surface of the coarse coat when set, and the wall should be thus tested before following on with the other coats. Should you discover such fault as I have been describing, it is best to cut out the faulty spot with a sharp chisel, and then make good. In any case of cutting about a wall after the plastering is on, no hammering or knocking about should be permitted, as the key of the plaster by which it is clenched to the wall may be seriously shaken by such rough usage. Imperfect adhesion of the final coat may also be discovered by sounding the wall surface in the manner suggested, and the remedy must be the same.

Draughts and summers' sun are dangers which must be guarded against, as they tend to dry out the plaster before it has time to set. On the other hand, your plaster will sometimes "go off" too slowly, that is, not get sufficiently steady and firm to take its proper face; and it is very trying to your patience to be obliged to sit and wait till your ground is ready for you. However, plaster should always be allowed to take its own time; and more haste will mean worse speed, should you try to begin "scratching" too soon.

I fear that this portion of my paper must sound very depressing to my audience. But since all the above causes of failure may with certainty be prevented by methodical foresight, perhaps this gloomy narration may be of service to future workers in sgraffito. Failures, properly considered, are but the first steps towards success. "The man who never made mistakes never made anything." So said Mr. Phelps. And this saying is just as true of workers in the arts and crafts as of workers in statecraft.

And now, in conclusion, I would say a few words respecting the manner of design which

seems to be permitted or suggested by this simple method.

That the manner should be founded upon a frank acceptance of line, and upon simple contrasts of light against dark or dark against light, is a saying that will scarcely be discussed; but as to the results to be achieved by means of sgraffito—that is to say, by means of incised work—here designers will be divided, and we shall find ourselves taking sides.

Shall our centre of aim be the production of a sumptuous background, in the manner of such and such a style, and keeping rigidly to one plane? Or shall a more graphic manner be adopted, and the artist express his sense of the joy of life, or the sorrow of life, or the beauty of life within the limits imposed by his simple means of expression?

One side seems to say, "Be not deceived; you are but foolish fellows who think to produce anything new in the ancient arts of design. It has all been done before. The designer who most cunningly plies his scissors in the beautiful storehouse of the past, and who most judiciously applies paste to the results of his labours, he is the man to represent the scientific self-conscious art of the waning 19th century."

The other side seem to say, "Beware of scissors and paste. Fresh feeling or perception is the test which decides whether a design is a vital expression or a scientific exercise. Let us use the methods of the past as a medium, just as a poet of to-day uses the metrical language of tradition to express his present perceptions of the joy, the sorrow, or the beauty of life. It is good that the poet should be skilled in all methods of versification, but it is not the one thing needful. It is not his centre of aim. So for designers, it is good that we should study the glorious achievements of the past, and thereby learn certain guiding principles true for all time; but our own manner of production must first depend upon Mother Nature, seen with fresh feeling or perception."

Indeed, the motive of all most beautiful graphic expression springs from fresh vision, wonder, and enjoyment; and this is a counsel of perfection which he who lingers may learn from the fragments of bygone arts which have survived the decay of time and the destruction of man. Splendid story-telling art has been produced in the past by means of incised surface decoration, as well as sumptuous backgrounds (the cypress wood chest front, and graffiati ware at South Kensington

Museum bear witness to my meaning); and should the craft of sgraffito become more popular in the future than it is at present, and should men again strive for that combination and unity of the arts in production which gives genius to a locality and fresh spirit to generations of beholders, I hope that more artists will then recognise the fair field that sgraffito affords for design that is not restricted to repeats, though its means may be scanty, and that may be made truly to belong to the place for which it is specially intended, and where it is actually executed.

But the manner of doing this—there lies the difficulty. It is easy to throw out a suggestion or to recognise the wide permission of treatments granted by past examples of surface decoration, but to achieve real, ideal results in any art or craft is quite a different matter; and truly it is not from choice that workers talk, for they know well the difference between practise and precept, and they fear lest the truth of their professions may fail owing to the shortcomings of their own performances.

The paper was illustrated by a demonstration of the method of cutting the sgraffito, and by a number of cartoons lent by the Science and Art Department. Mr. G. T. Richardson lent some specimens of sgraffito and a series of designs. Mr. Sumner himself also showed a number of designs.

DISCUSSION.

Mr. G. T. ROBINSON said he was unable to add anything to the paper, either with regard to the process or capabilities of this art, but he might give a short history of its revival. At the beginning of the 16th century, a collector of ancient sculptures had the highest praise in the world of art, which was then arising; and when the head of the house of the Medici was instructing his son, who afterwards became Pope, what he should do to make himself eminent, he told him not to waste money on gold or jewels, or to array himself in grand lace, like other cardinals, but to look out for antiques. Adopting this advice, Cardinal M. Medici dug and delved everywhere about ancient Rome seeking for pieces of sculpture, and in this way the Laocoon and many other fine works were discovered; and not only so, but in excavating for the baths of Titus, they found a great number of the old plaster decorations, which had been covered up and preserved, and they were found to be full of the grace and spirit of the early Roman work. From that time began the revival of plaster-work. Many charming old poetic examples were found engraved on the tombs, and one man

in particular, called *Morto da Feltro*, from his birth-place, and this habit of his of exploring these subterranean abodes of the dead, might be called the re-discoverer of this *sggraffito*, for he again practised it. He went to Florence and taught it, and the old walls of Florence were thus decorated in a charming manner for many generations. *Sgraffito* found its way, not only over Europe, but into England, about the time of Henry VIII.; and specimens were to be found at Hampton Court, and many other places. Then it fell into desuetude, and was once more forgotten. About 40 years ago, however, people again began to agitate for some other process of decoration, and *sggraffito* began to rise again. Thirty years ago he had the temerity to try it on a wall at Dartmouth, but, not knowing much about it, he found great difficulties. He let the plaster get hard, and cutting through hard plaster to a coloured coat beneath was a very painful process, and not a very satisfactory one; and the most you could do was to make a ragged edge, and cut your hands. By and bye people got to know more about it; then South Kensington took it up; and from then it went on to the point at which Mr. Sumner had dealt with it.

Mr. H. STANNUS said they were indebted to Mr. Robinson, not only for the addition he had just made to the stock of knowledge on this subject, but for the admirable specimens he had brought. He was an older man, and commenced *sggraffito* many years before Mr. Sumner, and even before Sir Henry Cole took it up; and to him, as much as anyone, was due the credit of having been one of the revivers of this art in England. He was an able architect; but he also had great sympathy with the ornamental side of that art, and always sought opportunity for making architecture not only beautiful in proportion, true in construction, convenient in plan, and perfect in sanitary arrangements, but also pleasant to the eye by the addition of those adjuncts of the applied arts which tended so much to beautify the work of the architect pure and simple. Coming to the paper itself, he might add one more to the preliminary cautions which had been given, namely, that the wall should be well settled before the work was begun, otherwise it would be almost certain to crack and spoil the design. He proceeded to observe that the grounds shown in the cartoons by the late Mr. Moody and Mr. Robinson were black or monochrome, whereas Mr. Sumner employed several colours, and this seemed to him to lead to some slight defects in treatment. On a monochrome ground the design may be made or modified during the progress of the work, and, in the hands of a real artist, it was an advantage; but with parti-coloured grounds the design must be made beforehand, and there is not the chance of much alteration. The variety of colours gives a more pleasing result, but, on the other hand, there must be some slight loss of freedom. He had great sympathy with this *sggraffito*

work; on a wall it appeared more monumental and more an integral part of the building than any oil painting possibly could do. Just as the carving upon the frieze round the Parthenon was cut out out of the actual masonry of the wall, and so appeared to be part of the building and not added to it, so in the same way the *sggraffito* appeared to be more part of the actual building than any mere appended decoration could be. This point was well illustrated in the photographs of the decoration of a church executed by Mr. Sumner. For monumental and public buildings of all kinds, therefore, there ought to be a great future for this kind of work. Ruskin said the greatest art in the world was done *for its place* and *in its place*. Obviously that which was done for its place must be superior in every quality that went to make any object artistic—to a picture which was hung over the sideboard to-day, and might be put anywhere else to-morrow. When, in addition to being done for its place, it was done in its place, it derived qualities from its surroundings, put into it by the artist, which could not come in any other manner. Thus the dictum of Ruskin was eminently true of *sggraffito*. The artist, while he could not modify the colour, could modify the feeling—the amount of black and white—and put into it the effect of the building itself. He might make cartoons at home, but when he came to put them up in a church he might find that in a dark corner he wanted rather a broader effect, whereas in a lighter part he could introduce a finer work. He was pleased with the plea for modernism: all art should be essentially of its own time. His view, to which he wished to commit no one else, was that a man to whom was committed the talent ought to represent the life of this century in the centuries that were coming. His duty was not towards some event which happened in bygone days, but with the things which were happening to-day. There were as great and noble things happening every day in England—even in London—as ever happened at any period of the world's history; and all the great artists owed their greatest work—(with the exception of Bible events, which belonged to all time)—to the events of their own time. *Sgraffito* was essentially an art which lent itself to this time, and he was much pleased to see the thoroughly modern manner in which Mr. Sumner had employed it in the decoration of churches. He trusted he would continue in the same course, and that his work would remain for many generations, and give our descendents in the future some idea of our 19th century mural decorative art.

Mr. COBDEN SANDERSON said it was very interesting to hear the history of the resuscitation of this art, and he wished he could add anything to the discussion; but the only thing which occurred to him, as it always did whenever he was present at a lecture on art, was the extreme interdependence not only of

all the crafts one upon another, but of all the industries which lay at the basis of the fine arts themselves. There seemed to be an almost superhuman task in hand whenever some great work was undertaken, the whole burden and direction of which seemed to fall on the one man whose genius had designed it. If one could instil into the plumber, the bricklayer, and even the labourer, some conception of the whole work of which he was doing a humble part, they might hope that some of the great ideas which were in the minds of artists might have an adequate result. It seemed impossible, at present, to get that consensus of feeling and aim, and he did not know how to achieve it, except by steps which it would not be proper to allude to there. He had been much interested in Mr. Sumner's remarks on the style of design to be adopted, and was almost inclined, at first, to approve of the suggestion of going back to the past, and selecting the finest examples for reproduction; but when he came to the alternative, to what might be called the inspired side of art, the depicting of fresh things—things which were always the same and yet were always different—he felt, as he thought all must, that design was really invention; it was a new way of saying old things, and if it was not something fresh it was hardly worth while doing it at all. He did not see the necessity for the ornamentation of a thing in itself; we did not live by it. It seemed a superfluous addition to a useful thing unless it were the expression of a man's primary apprehension of this wonderful universe, or some portion of it, round about him. He should be inclined to say "Abstain from decorating a useful thing, let it stand on its own merits; but if you feel any joy in adding to its utilitarian side, if you love it, and have some method of expressing your love, then do it, and you will then not only enjoy it more yourself, but all who see it will enjoy it in a higher way." How this was to be done he hardly knew. There was an immense machinery at South Kensington, but he was somewhat doubtful as to the results it was achieving. Perhaps the field must be cleared by a little abstention, and then in time to come the people would be able to take a fresh view of things.

THE CHAIRMAN, in proposing a vote of thanks to Mr. Sumner, said the subject of his paper was not much known, and yet it had an interest of its own, and was deserving of some attention; and he was glad to hear from the discussion that, in the opinion of some of the speakers, there was a future in this country for that beautiful art. It was rather discouraging to hear that its modern representative in this country was the delineation of stone blocks on a wall of plaster by what was called jointing, especially when one remembered that in the 16th century the art attained some degree of perfection. He hoped, however, that this renaissance hoped for here might turn out to be a fact. The process itself might be divided into two—the artistic and the mechanical—and while the former

had a claim upon one's sympathy, the mechanical part seemed rather lacking in that respect. However good and imaginative the design might be, it had to be translated into absolute mechanical operation before it was presented to the public eye, and thereby some of the artistic feeling of the design itself might be lost. Other modes of wall decoration were, perhaps, less open to objection. One of the sights of Windsor was the Albert Chapel, which was lined with marble, and that marble was incised or scratched by Baron Trechetti. There you had the absolute work of the artist himself, without any mechanical process. It was the work of his own fingers, just the same as a great picture was the work of the painter. In sculpture, again, the artist made his design in clay, and then turned it over to a mechanic to bring it very nearly, but not quite, to the right form; and before the statue was finished, it had again the artist's own work upon it. They would all agree with Mr. Stannus that it was very desirable that decorations, whatever they might be, should be as much as possible part of the structure, and executed *in situ*, under the conditions, distances, points of sight and atmosphere under which they would be seen. He lately heard an interesting paper at the Institute of British Architects, by Colonel Jacob, describing some artistic work in a building at Jeypore, erected under his direction for the Maharajah, in which all the enrichments and mouldings were put up in plastic material and executed *in situ*. Mr. Sanderson had laid down what all would receive as an axiom, that while the principles of art, and even expression to a certain extent, might be considered catholic and intelligible to all time, when they represented the feeling and passions common to all mankind, yet the particular expression of that art should be identified as much as possible with the age in which it was executed; in order that it might become historical and interesting to those who came after, just as the characteristic work of past ages was interesting to us. He was sorry to say he had not recently seen the examples of sgraffito at South Kensington, but he was very pleased to hear that even those in the open air had not suffered from the English climate. He thought all would agree with his concluding remarks in depreciation of mere copying, in which he drew the distinction between vital expression and scientific exercise. Personally, he had not had anything to do with this art, nor did he remember any examples of it in Italy, where he supposed it was chiefly carried on, and it would have been very interesting if some specimens or reproductions of ancient examples could have been given.

The vote of thanks having been carried unanimously,

MR. SUMNER, in reply, desired to thank the authorities at South Kensington for their courtesy in sending the cartoons representing some of the designs carried out there, and Messrs. Trollope for

the fine display of cartoons and specimens of work executed under the learned direction of Mr. G. T. Robinson which they had courteously lent for exhibition. In reply to Mr. Stannus, he would say that with the variously coloured ground you could not alter the figure work or the main character of the design, but the borders and ornamentation might be varied, and he constantly did so in carrying out the work, in order to suit the building. It was no doubt rather a heavy task for one man, as Mr. Sanderson said, to look after everything, but most plasterers did their work commercially, which was a very different thing from doing it artistically. They wanted to do it as quickly as possible, and the artist wanted to do it as soundly as possible. You must understand the whole business, and see that your orders were really carried out. He could assure the Chairman that the whole of the work was artistic; true, he had an able assistant, but he himself was entirely responsible for the whole thing from beginning to end. There was more art in doing the real work than in drawing the cartoons, which he did not consider artistic, as a design of that sort was not suitable for carrying out on paper, but it was suitable for plaster. The cartoon was only the means to an end. In conclusion, he would draw especial attention to the good effect produced in certain cases by the introduction of a little mosaic work, to add lustre to the work.

TENTH ORDINARY MEETING.

Wednesday, February 11th, 1891; the DUKE OF ABERCORN, C.B., President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Buckeridge, Walter, 13, Durham-terrace, Westbourne-park, W.

Codd, John, 16, Hill-road, St. John's-wood, N.W.

Crews, Arthur E., 41, Portman-square, W.

Green, George William, 42, Duke-street, S.W.

Hunter, George B., Wallsend-on-Tyne.

Newton, Ernest, 14, Hart-street, Bloomsbury-square, W.C.

Stead, John Edward, 5, Zetland-road, Middlesborough.

Treize, J. M. G., Moreton-house, Redruth, Cornwall.

Williams, Montague Scott, J.P., Woolland-house, near Blandford, Dorset.

The following candidates were balloted for, and duly elected members of the Society:—

Butterworth, John Cyrus, 18, Finch-lane, E.C.

Cannell, Henry, Swanley-junction, Kent.

Clanwilliam, Earl of, K.C.B., K.C.M.G., 32, Belgrave-square, S.W.

Evans, John Henry, Fairlight-villa, Elsworth-road, Primrose-hill, N.W.

Ranken, Charles, Stockton-road, Sunderland.
Walker, J. M., Mancunium, Anerley, S.E.

The paper read was—

THE PROPOSED IRISH CHANNEL TUNNEL.

By SIR ROPER LETHBRIDGE, K.C.I.E., M.P.

When the Council of the Society of Arts did me the honour of asking me to read a paper on the proposed Irish Channel Tunnel before the Society of Arts, I gladly accepted their invitation; for I know of no better way of starting public discussion, and arousing public opinion about the advantages of such an enterprise as that of which I am to speak to-night.

If an Irish Channel Tunnel is ever to be built, at least in our time, it will have to be built largely, in the first place, at the cost or with the guarantee of the State, as a great public work of national and imperial importance. No Government will ever spontaneously undertake such an enterprise. No Government will ever dare even to suggest such an expenditure, or such a risking of the taxpayers' money, unless it be forced to do so by a great volume of public opinion throughout the country. My paper to-night does not pretend to be more than a very humble and preliminary effort to draw public attention to the subject.

To myself, as a Member of Parliament, it is a great pleasure to be able to speak on any Irish subject that cannot by any possibility lend itself to partisan treatment from a political point of view. I observed the other day that, at a meeting held at Cork to consider the Transatlantic Mail Service, one of the resolutions was supported in turn by Irish gentlemen of such divergent political opinions as Mr. Maurice Healy, M.P., Mr. Penrose Fitzgerald, M.P., and Mr. Flynn, M.P. It is pleasant to see union such as this; and I am very confident that not only Irishmen, but also Englishmen and Scotchmen, of all shades of political opinion—whether they may ultimately think that any form of the scheme I suggest is feasible or not—will sympathise with the objects I have in putting it forward.

I wish at once to say that I shall not attempt to form a judgment or express an opinion on the details, whether of cost or of feasibility, of any particular scheme for an Irish Channel Tunnel. I am well aware that the judgment of the country will ultimately have to be satisfied in regard to every such detail, before any

real or powerful public opinion in favour of any scheme will be formed. But, on this side of the Irish Channel, we have not yet arrived at the stage when such details can be usefully discussed. I venture to think that, if some public interest can be aroused in the general outlines of the various schemes that have been suggested, we shall have done good work this evening. And then, if my audience to-night, and the public that is behind them, decide that it is very necessary to have a Channel Tunnel, the next step will be for a Royal Commission to thresh out the details.

In Ireland they have already developed the idea to a further stage, and have been profitably discussing details. At a most important meeting held in Belfast last October, under the presidency of the Mayor, Mr. Barton, a civil engineer of distinction, expounded a scheme for a tunnel by what seems to be a most hopeful route, "by taking a line from Islandmagee, running north-east by east," to the coast of Wigtownshire. The well-known name of Mr. McCullough has long since been identified with a proposal to construct the tunnel between Whitehead and Portpatrick. Then there is the northerly route, by way of Cantyre—by far the shortest sea route, and brought forward some years ago by Mr. W. Scott and Mr. Livingston Macassey. A fourth route has found supporters—from Donaghadee to Portpatrick—but there is a deep depression or trough running across that route near the Scottish shore, and giving the enormous depth of 900 feet to the channel, that would entail terribly heavy gradients, lengthened approaches, and such difficulties of construction as would make the expense impossible.

Besides these four routes for a tunnel, a most ingenious device for through communication was last year suggested, and its details worked out at some length, by Mr. Maxton, at a meeting of the Belfast Natural History and Philosophical Society. This was to be by means of a submerged tubular bridge, with its roadway at a depth of 60 feet below the level of the water.

I may quote a very brief description :—

"The tube was described to be of circular or elliptical form, made of steel plate, and coated on the outside with cement or other protection against corrosion. Within the outer shell a rectangular inner tube was to be formed, and in this the roadway was to be laid. The bridge was to be constructed in 400 feet lengths, made complete for launching. Special arrangements were suggested for attaching the lengths together under water, and

the whole structure was to be kept in position by means of chains and anchors. At intervals of 500 feet were water-tight doors, so arranged as to close in cases of emergency; the rear of the trains to be so designed as to act as a piston, in order that, in case of an inrush of water, the train might be forced out of the tube. Necessary ventilation would be secured by means of the motion of the trains. Mr. Maxton estimates the cost of the bridge, complete, at £5,250,000. The trains using the bridge were to be operated by electricity, or compressed air."

A Channel Bridge, after the fashion of that glorious erection the Forth Bridge, only multiplied several times, has been spoken of as a possibility of the dim and distant future. So, too, has a Causeway, to be laid down after the fashion of the Plymouth Breakwater, and only thirteen times the length of that prodigious structure. But though no one, after the recent exploits of engineering and audacity, would dare to call either of these proposals impossible, yet it is obvious that neither the one nor the other is at all likely to take the place of a tunnel.

No one who has followed the course of the discussion on the proposed Channel Tunnel between England and France—a discussion which the energy, the ability, and the tenacity of Sir Edward Watkin threaten to make perennial—can doubt for a moment the perfect feasibility of a submarine tunnel being constructed, and being worked, for almost unlimited distances. It is simply a question of cost. Drainage, pumping, ventilation—it is all a question of cost.

So far as the amount of that cost depends on the nature of the rocks to be cut through, the testimony of Professor Hull, the head of the Geological Survey, in regard to the nature of the geology of the adjacent coasts, is conclusively in favour of the probability of easy working. But however that may be, there is no doubt that the hardest rocks yield to modern rock drills and modern explosives far more easily than the softest formerly did to the appliances of our fathers. We can "caulk" or "case" the most obstinate fissures. We can roll out the tube in which we live and work as we go along.

This is what Professor Hull says of the physical difficulties to be encountered :—

"The question, not perhaps of the practicability of the tunnel, but of its cost, certainly depended largely upon the nature of the strata which would be encountered. It might be asked, How was it possible to form any idea of the stratification beneath such a wide expanse of sea? In attempting to form

a conclusion on such a point, they must of course be guided by the character of the strata in the surrounding land surfaces. He felt satisfied that in this case the data were sufficient to enable them to arrive approximately at a fair estimate of the nature of the rocks and strata to be encountered in making the tunnel. Partly from actual knowledge of the stratification as gained by the Geological Survey of Ireland and Scotland, and partly from older sources, he would endeavour to describe and trace the strata on the tunnel line. The general succession of the strata on the Antrim side many of those present would doubtless be familiar with. The newest of them was of course the great tabular basaltic formation which covers the surface of Antrim. This rests upon the white limestone of the chalk formation, and that again upon the representative of the lias and rhætic formations which are very meagrely represented in this part of the country. These strata in turn rest upon the new red marl, and this again upon the new red sandstone. This series of strata belong to the secondary formation of rocks. In entering the surface at the commencement of the channel, where it would join the Northern Counties Railway, they would pass into the red marl formation. It was quite possible they would have no other strata throughout. There were, however, sometimes associated with these red marls beds of gypsum and rock-salt, such as were found at Carrickfergus. At first he was apprehensive that those beds of rock-salt, such as at Duncrue, might be a serious difficulty in the construction of the tunnel; but, on reconsideration, he had abandoned that view, because, if they were there at all, which was not quite certain, they had been there for incalculable ages, and the tunnel would not reach them, being not at a sufficient depth. On the eastern coast of Islandmagee they would encounter, doubtless, one or two of those "faults," or fissures, by which the strata are let down or displaced; but it was very uncertain whether the displacement would be sufficiently great to cause them any inconvenience at all; and, from what had fallen from Mr. Barton, it seemed tolerably clear that in any case they need not fear any great influx of water, because the fissures would be sealed rather than open ones. They might have, in tunnelling from Islandmagee, a long distance of this new red marl substituted by the new red sandstone where the strata were let down by the fissures. The distance through these marls would be, he had concluded, about five or six miles from the coast. The tunnelling through them would be extremely easy, and would mean a large reduction upon the estimate for the ordinary rock boring. After leaving the new red sandstone formation, somewhere about one-third of the distance across, they would, in all probability, have throughout the entire remaining distance the rocks of the lower silurian system; and the geology of the coast of Wigtownshire indicated that these silurian strata would continue to the point where the proposed tunnel would emerge. In con-

clusion, he might say that he felt perfectly satisfied there were no geological difficulties likely to be encountered in the construction of the tunnel which engineering skill would not be fully able to meet."

This is evidence of the first importance, when we consider Professor Hull's official position and great attainments. And it does seem to me that the experience gained in the construction of the Mersey tunnel demonstrates not only that we can construct and work sub-aqueous tunnels with perfect certainty and safety; but when its cost is compared with that of other long tunnels, we see that the tendency of modern discovery is greatly to diminish the cost of such works per mile. At the same time, it must be admitted that the Severn Tunnel, on the other hand, has proved unexpectedly difficult and costly; and its details ought to warn those who take up the Channel Tunnel that unforeseen difficulties may occur. Once more, it is a question of cost; and the following Table shows that the general tendency is for this cost to diminish as time goes on:—

TABLE OF EXPENSE OF LONG TUNNELS.

Date.	Name.	Length in miles.	Cost per mile.
1851 to 1871 ..	Mount Ceniz	7·97	£ 394,240
1872 to 1882 ..	St. Gothard	9·31	249,920
1880 to 1884 ..	Arlberg	6·36	190,080
1885	Mersey	1	140,800
....	Severn	4	500,000

Putting aside the Donaghadee Tunnel—its cost has been estimated at £16,000,000—as clearly out of the question, there remain the three other suggested tunnels—Mr. M'Cullough's, Mr. Barton's, and Messrs. Scott and Macassey's—as well as Mr. Maxton's proposal for a submerged, tubular, buoyant bridge. And it seems that the cost of these are variously estimated at from £5,250,000 up to £10,000,000. For a sum within these limits, or not largely exceeding the higher limit, there seems to be no doubt whatever that the tunnel can be made, and that we can have through trains from London and Glasgow to Londonderry, Galway, and the West of Ireland. Mr. Macassey, in an admirable pamphlet (price 6d.) on the subject, published by Forrest, of Glasgow, and Mullan of Belfast, only three months ago, has stated very fully and carefully—and

as I think with perfect fairness and impartiality—all the *pros* and the *cons* of these various schemes respectively. Of the proposed Whitehead and Portpatrick Tunnel, or Mr. M'Cullough's scheme, Mr. Macassey tells us:—

“The length of sea tunnel would be $23\frac{1}{2}$ miles, and land approaches $3\frac{1}{2}$ miles, making in all some 27 miles; the greatest depth of sea bottom being 650 feet. The ruling gradient to be 1 in 58, and the estimated cost would be about £7,000,000; but if Mr. Barton's figures of £300,000 per mile be taken, the cost would amount to £8,100,000. The author of this proposal claims that the tunnel as suggested would be more conveniently situated with respect to the existing railway than any other more southerly or more northerly route; that it is the shortest route with good gradients; and further that the cost would not be excessive.”

Of the Cantyre, or most northerly route—the one favoured by Mr. Macassey himself—that gentleman says:—

“The total length of sea tunnel is only some $14\frac{1}{2}$ miles, and the total length, with approaches, some 24 miles. Not only is this the shortest possible route, but the sea portion is little more than one-half the sea length of Mr. Barton's tunnel. The tunnel to be for a double line of rails, with a ruling gradient of 1 in 60, but having level stretches of half-a-mile each at intervals, an arrangement much more satisfactory than a long length of gradient, even when the latter is so easy as 1 in 75. Connecting lines of railway would be required on both the Scotch and Irish side. In the former case a new line from the Mull of Cantyre, by Campbeltown round by Inverary, and connected to the West Highland Railway now being made, at a point south of Crianlarich. The total length of the new line would be about 100 miles. Then there would be the Belfast connection of some 24 miles to Larne, and a connection to Londonderry by junction with the Northern Counties Railway at Ballymoney, the length of this branch being 20 miles. Nothing has been done by the advocates of this route to test the nature of the rocks to be intersected by the proposed tunnel. The information afforded by the exposed surfaces on either side are favourable, even more so than at Whitehead; but it is only possible to surmise what is under the bed of the channel. All that can be said at the present stage of the matter is that, everything else being the same, the sea tunnel of $14\frac{1}{2}$ miles has more probabilities in its favour, as regards successful completion, than any of the other schemes involving greater length of sea tunnelling.”

Such, then, are the routes for a tunnel that have found advocates thus far, such their mileage and estimated cost. Whether full

inquiry by a Royal Commission, which would clearly be necessary before arriving at any decision on a question of such magnitude and difficulty, would result in the adoption of any one of these routes, is of course quite uncertain.

The questions that now remain are—first, Is the game worth the candle? and, secondly, if so, how is the candle to be provided?

I will consider the latter question first.

Mr. Macassey has shown—and the other authorities to whom I have alluded say much the same thing—that, on the most moderate computation, a mileage earning of more than £200 a week would be required to make the scheme commercially a remunerative, or even a self-supporting one. As the mileage earnings of the most prosperous railways, with the heaviest traffic in existence, are only a fraction of this amount, it is obvious that other sources of revenue must be looked for, to help to defray the cost.

I will venture to indicate three other possible sources of revenue.

First, the railways on either side that may be connected with the tunnel will clearly derive enormous benefits from the communication. And they may be fairly called upon to contribute *pro tanto*, perhaps in the form of a small guaranteed per-centage on the capital.

Secondly, the whole line of country between the Irish end of the tunnel and the ports on the Western Coast that will then become the terminal stations of the great Transatlantic routes—will (as I shall presently endeavour to show) become, in all probability, immensely enhanced in value. Great commercial and manufacturing centres of population and wealth will certainly grow up along these routes; and, it seems possible, that the popular doctrine of “betterment,” if properly and fairly applied by legislation to these routes, might go far to supplement the revenues of the tunnel.

And thirdly, and lastly, if the people of Great Britain and Ireland determine that the enterprise is one of such vast national and Imperial advantage as I venture to suggest, then Parliament will be found ready and eager to provide the balance of the cost, whether by voting an annual guaranteed per-centage on subscribed capital, or by the actual provision of a portion of that capital by means of a loan in the first instance. In the latter event, I see no reason why the tunnel itself should not be constructed and maintained by a Department of the State. In the Postal and

Telegraph Departments, the State already undertakes similar commercial functions, and conducts them on a commercial basis. I cannot imagine any form of public works of greater public utility than this tunnel.

Finally, then, I ask, is the game worth the candle?

I think it is hardly worth while to notice two objections that have been raised—that the tunnel route may injure (1) the existing lines of sea communication between Great Britain and Ireland; and (2) the prestige of Liverpool and other English ports as ports for the Transatlantic trade. Nothing can rob Liverpool, Bristol, Cardiff, and the other ports on this side of the Channel, of their proximity to British manufacturing and mining centres; and the vast increase of inter-communication between the sister islands will cause the routes by Holyhead and Kingston, and Larne and Stranraer, to be more thronged than ever before.

Consider for a moment the enormous advantages to both islands that must inevitably follow from the opening up of Ireland, and from its rapid enrichment. The line of country between the tunnel and the western ports of Ireland will be that part of Europe that is nearest to, and most closely in connection with, not only the United States and Canada, but also the Australian colonies, China, Japan, and the Pacific generally. In an important address delivered yesterday before the London Chamber of Commerce, Sir George Baden-Powell showed clearly that the new mail route to the East generally will in all probability go westward before long, by the way of the Canadian Pacific Railway. And Lord Hartington a few weeks ago, when proposing the health of a powerful newly-launched steamer, the *Empress of Japan*, intended to run between Vancouver and Japan, used most significant words in regard to the future of this route. He said that he trusted that in a short time a new enterprise would be launched, which "would open up direct communication between British ports and Canadian and Atlantic ports, and thence, by means of the Canadian Pacific Railway and the Grand Trunk Railway, to open up not only steam communication with China and Japan, but with the Australian colonies."

Both Lord Hartington and Sir George Baden-Powell, in the speeches to which I have referred, were doubtless looking chiefly to lines of steamers from British ports to Canada. But a glance at the map of the world

will show that the west coast of Ireland, if only it were in direct communication with the great manufacturing and mining centres of England and Scotland, is the natural outlet for the Transatlantic trade of Europe. The Irish railways between the Tunnel and the west coast would be the last section, on the side of the Old World, of the great British trade routes girdling the world.

The immense advantages, both for commerce and for manufactures, that must immediately accrue to such a position, are obvious. It is, I believe, universally admitted that the mineral resources of Ireland have never been properly exploited; but how eager would then be the search, along such a line as this, and how rich the reward of every discovery! The cotton and other products of the New World, and even the riches of Australasia, China, Japan, and the Pacific generally, would be most speedily brought to the factories that would immediately spring up along this line; and the manufactured goods produced therein would also be situated in a position more convenient than any other for immediate access to the markets I have named. It seems to me impossible to exaggerate the great changes likely—nay, certain—to be brought about in the economic condition of the whole country of Ireland by the full development of this great trade-route.

Then I would ask you to consider the immense advantage to both countries of free and frequent intercommunication between all parts of the two islands. For one Englishman who travels in Ireland, probably fifty visit Scotland, the sea alone making this difference. It is indisputable that the resources of Ireland are largely undeveloped, very much because it is a *terra incognita*; when once the tunnel had been constructed, Cork and Londonderry would be as well known as Glasgow and Liverpool. At present, notwithstanding the admirable mail services kept up between Holyhead and Kingstown, and to a less extent between Larne and Stranraer—I believe it is not an unusual thing for Belfast merchants to have to wait for their London and Glasgow letters, by reason of the badness of the passage made. Even apart from the great manufacturing and commercial possibilities of this route, I should be inclined to press it upon the attention of the Government, if only for the sake of the solidarity it will bring about between the populations of the two islands.

For a considerable portion of the year—when the heat of the Red Sea is so excessive

as to make that part of the overland route to India, and the East, and Australia unhealthy, and sometimes even dangerous to life—the westward route would be far preferable in every way. At all times it would be safer and more easily navigated. And then I should like to point out the advantage in time of war or disturbance, of possessing such an alternative mail-route as the one I suggest—a route that never leaves British territory, and along which “the sun in its circling course is followed by the roll of the British drums.” I am glad to think that last night the London Chamber of Commerce was stirred to enthusiasm by the prospect of such an alternative route. But, surely, if that Westward Route be once established, we shall inevitably be forced to shorten the sea voyage, even if such heroic measures as an Irish Channel Tunnel are necessary. It is doubtful whether the Mont Cenis Tunnel would ever have been built, but for the stimulating fact that its construction gave to Italy to play that part on the eastward route that Ireland will play on the westward route, when the tunnel is made. The eastward route has migrated from Marseilles to Brindisi, and may hereafter migrate even further east again. And, in like manner, I feel confident that, when we have a westward route, we shall not be content until we have placed its European terminus as far west, and as near to the American Continent as the geographical conditions will permit. That terminus will be on Irish soil, and the Channel Tunnel will be our Mont Cenis.

DISCUSSION.

Mr. JAMES BARTON said he had been very much interested in listening to the paper, as it dealt with a subject of which he had been thinking for some time, and endeavouring to throw a light upon. In conjunction with Sir John Hawkshaw's firm, he had been investigating the subject from a scientific point of view, and though the matter involved considerable difficulties, yet none seemed to be such as would daunt anyone who would enter upon the project. The opinion of Professor Hull, which had been already largely quoted, carried great weight as to the geological questions. They had received from the Admiralty every facility in getting at the original surveys and soundings taken in the Channel, and of the kind of material of which the bottom was composed, and the result had been tabulated. There was a very remarkable depression in the Channel called Beaufort's Dyke—a deep gorge about 900 feet, running down to the south point of Wigtownshire.

It was of considerable width in parts, and branched into two channels on the northern end. It had occurred to him (Mr. Barton) that it would be possible to get round the end of the dyke, though by so doing the sea portion of the tunnel was slightly lengthened, but it did not materially increase the whole length, as the approaches would be shortened. The total length would be between 33 and 34 miles, the tunnel under the water being about $24\frac{1}{2}$ miles. A line straight across would go across the dyke. Until further investigations had been made as to the bottom of the sea, and borings had been made, the project could not be considered as definitely settled. So far as the investigations had already gone, he was of opinion that they ought not to hesitate, and that further investigations should be made in the best way, and as soon as possible. One result of the tunnel would be that trade as well as civilisation would be greatly advanced. The question of finance might be dealt with by receiving Government assistance, and from other sources. Ultimately, he believed, the profits would be sufficient to make the enterprise a commercial success, especially as there would be four railways which would be very much interested, and therefore might be expected to assist. The question of ventilation was an important one, but he would leave Mr. Hayter to deal with this.

Mr. F. W. M'CULLOUGH did not think the deep gorge which had been referred to would form a fatal objection to the proposed Whitehead and Portpatrick tunnel, especially considering that the gradient was most favourable, being 1 in 58 as against 1 in 32 by Mr. Barton's route. Again, the Whitehead and Portpatrick tunnel would be six miles shorter than any of the others, so that the cost of construction would be much less, the length of the sea tunnel being $23\frac{1}{2}$ miles, and land approaches $3\frac{1}{2}$ miles, making in all about 27 miles. The greatest depth of sea bottom was 650 feet. By this route, as compared with the others, the distance would be 8 miles shorter to any place in Scotland or England. At present no borings had been made; but, from all the facts in their possession, he had no doubt that the Whitehead and Portpatrick route was the most favourable one which had as yet been proposed.

Sir EDWARD WATKIN, Bart., M.P., said he had learnt that Sir Roper Lethbridge took a deep interest in one or two great Irish questions which had lately been troubling his own mind, and upon which he had spent some time, and, necessarily, some money. The first question was that of uniting Scotland and Ireland, and the other was that of bringing the west coast of Ireland within $3\frac{1}{2}$ or 4 days' journey of the American continent. That involved, of course, the construction of a ship canal between Galway Bay and Dublin Bay. Having had the neces-

sary surveys made and plans prepared, Mr. Walker, the contractor for the Manchester Ship Canal, informed him that for £8,000,000 a magnificent ship canal could be completed from the eastern to the western coasts of Ireland, thus making Ireland the halfway house between England and America. If this undertaking were commenced, it would settle many difficult Irish questions. You could not elevate the people of any country without raising their wages, and this could not be done without providing more employment. Providing more employment meant facilitating the means of inter-communication between man and man, and the rapid and cheap transmission of the products of industry and of raw materials. If Sir Roper Lethbridge would put a notice on the paper of the House of Commons for the appointment of a Royal Commission to investigate these two subjects, he should have very much pleasure in supporting him. In dealing with tunnels under the sea, one difficulty they generally met with was the fact that many able engineers were not geologists, and many able geologists were not engineers. This difficulty was met with in the case of the proposed tunnel between England and France. He had been delighted with Mr. Barton's plan of getting over the difficulty of the dyke, viz., by going round it, and considered that the little extra length occasioned by so doing was not of any great importance. In the case of the Channel tunnel, Sir John Hawkshaw and the geologist who worked with him took a ruler, and with a pen drew a straight line from Sandgate to St. Margaret's Bay, the effect being that sometimes the tunnel was in the upper chalk, and sometimes out of it. By this plan they would have had to pump the sea to begin with, then to drain the land, and to do an amount of timbering which rendered the scheme almost impossible. He at once said that it would not do, and that they must go down below to the grey chalk, which was impervious to water. This chalk was soft enough to be cut by machinery, and hard enough to stand on its own legs, the *débris* removed being valuable for cement. By finding the grey chalk at its out-crop, and following it, all difficulty was avoided, and the tunnel would be one of the cheapest engineering works that had ever been constructed. So that by getting round the difficulties in the present instance Scotland might be connected with Ireland cheaply, though not perhaps so cheaply as in the case of connecting England with France. He had been offered a contract to make two single-line tunnels through the hardest piece of rock in England at £46 per yard, and taking the distance under the grey chalk at twenty-two miles, this would amount to about £85 per mile. He did not think the Irish Tunnel could be constructed for this sum, but supposing it cost ten times as much, the project was worthy the attention of England, and the rich people of England. The making of the Irish Tunnel and the Ship Canal would be the making of Ireland; wages would rise, and in fact, the effect would be to

revolutionise the present degraded position of a large portion of the people. Assuming the Ship Canal would cost £10,000,000, and the Tunnel £10,000,000, this would, calculated as a 3 per cent. terminable annuity, come to about to about £600,000 a year, or about a farthing in the pound on the income-tax of the people of England, Ireland, and Scotland. He was quite sure that every one would be willing to bear this extra burden, in order that such a desirable object might be accomplished. So far as his humble assistance would be of any value, it was entirely at the service of the reader of the paper.

Mr. HARRISON HAYTER said many preliminary investigations had been made by Mr. Barton, which, so far as they went, were very valuable; but of course they were not complete. Still, they showed there was a reasonable probability of the tunnel being possible, and that the railway could be made with good gradients. What was wanted to advance the question was further preliminary investigations, and more borings and soundings, which would enable them to arrive at a better idea with regard to geological facts. These investigations could be completed for about £10,000 or £15,000. The next step would be to sink shafts on each side of 30 feet diameter, which would constitute part of the permanent work, and this would cost about £100,000. If the strata were not very much broken, they might go on with the tunnel without further investigation; but if the strata were very much broken, they would have to drive headings under the channel, which would cost more money. So far as he had gone into the estimates, he believed the tunnel would cost about £10,000,000, and take ten years to complete. Tunnels now did not cost so much as formerly, on account of the first-class machinery which they could now get, and not only so, but they had all the preparations of nitroglycerine, and the like. His firm had lately made twelve tunnels in India with very indifferent labour, although the rock to be pierced was of the hardest description. As to ventilation, he thought this question had been very much misunderstood. There were three kinds of ventilation required; first, for driving the driftway; secondly, for constructing the tunnel; and thirdly, the permanent ventilation. As to the first, the simplest plan would be to put down pipes and draw the air from the end of the driftway. During construction it would be necessary to provide rapid means for bringing in materials and removing the *débris*, and this could be done by means of tubes, as was done by the Post-office. As the tunnel would be of great length, it followed that the men would have to travel an average distance of from $6\frac{1}{2}$ to 7 miles, and therefore they proposed to take the men in and out through the tubes. He had no doubt this could be done, and at the same time they could facilitate ventilation, if not provide for it entirely. The permanent ventilation could be provided by means

of a fan and an engine at either end. In the case of the Severn Tunnel, an engine of 250 horse-power was erected, capable of driving a fan at the rate of 50 revolutions a minute, but although it was only worked at half this number of revolutions the ventilation was simply perfect. He had heard engine-drivers say that they wished all railways were like this tunnel, for they were sheltered from the inclemency of the weather, and the air inside was quite as good as that outside. In making the Irish Tunnel they would first of all sink shafts, and then drive driftways, which would provide for the drainage during construction, and enable the working to be commenced at eight different points. The section of the tunnel would be a complete circle. Upon the whole, he had arrived at the following conclusions; first, that there was every reasonable probability that the work could be accomplished. It would be improper to say that it would not be attended with a certain amount of risk, but this risk was small, and not more than that connected with the construction of the Severn Tunnel. The second conclusion was that the risk was limited to one contingency, viz., the possibility of sea water finding its way through some unforeseen fissure in too great a quantity to be overcome. Apart from this, the construction of the tunnel was simply a question of time and expense. The third conclusion was that the question of risk would be fully solved by sinking permanent land shafts on each coast, and driving driftways a portion of the way. The fourth conclusion was that the loss, if any, would be measured by the cost of the preliminary shafts, estimated at £100,000, or, in an extreme case, by the cost of the driftways. As to meeting with fissures, he believed that, starting from the Irish side, the work for one-third of the distance would be through the new red sandstone and marl, the remaining two-thirds being through silurian rocks, which were very hard. As they would be 150 feet from the surface, he believed the fissures, if any existed, were almost sure to be filled up. Then the working expenses of the line would be very small, about one-half of the gross receipts, on account of the absence of stations. The traffic could be worked at 10 per cent., to which must be added the cost of ventilation and pumping, but altogether it would not amount to more than half what it did on railway lines generally. As they would be free from snow and rains, the cost of maintenance of the permanent way would be very small indeed. One thing to be remembered was with such a line abnormal rates would be allowed. The Severn Tunnel was seven miles in length, and Parliament had sanctioned a charge equal to a fourteen mile rate. As the proposed tunnel would be thirty miles long, he had no doubt Parliament would let them charge a sixty mile rate.

The CHAIRMAN asked what would be the ordinary temperature in the tunnel.

Mr. HAYTER said he was not prepared to answer the question precisely, but the temperature would not be very high, as the air would be continually changed. He thought the best thing would be to form a small company, with a capital of from £10,000 to £15,000, to make the investigations he had mentioned. He should be quite willing, and no doubt Mr. Barton would be also, to act without fee or reward until the undertaking was placed on some definite footing.

Mr. W. TOPLEY, F.R.S., said, as a geologist, he had followed with very great interest the extracts from Professor Hull's remarks, but he was afraid, to non-geological minds, they would not quite explain the geological conditions. The southern tunnel, as proposed, would pass wholly through silurian strata. The new red sandstone and marl beds were horizontal on the Irish side, and the tunnel now particularly under consideration would go through this rock for about one-third of the distance. Of course there might be faults in the rock. It would then come to the silurian rocks. On the Scottish side there would be silurian rocks for two-thirds of the way. These rocks could be seen distinctly on both sides of the coast, and were vertical, whereas the red sandstone was almost horizontal. On the southern line there was no doubt the silurian strata went right across, and the tunnel through this strata would, in many respects, be more suitable and safer. The silurian rocks, although hard to get through, were exceedingly compact, so that there was no danger to be expected from water. He did not anticipate any serious difficulty even if the northern route were chosen. The difficulty from water in submarine tunnels had always been enormously exaggerated in the public mind. Mechanical appliances for pumping had so vastly improved of late, that it was in the highest improbability that any difficulty from water could not be overcome.

Mr. J. B. LENO pointed out, in connection with the Cantyre scheme, that no mention had been made of Mr. Charles J. King, an engineer who had published a pamphlet, entitled "The Land Junction of Great Britain and Ireland, by an Isthmus at the Mull of Cantyre."

Sir ROPER LETHBRIDGE said he had only heard the names of Scott and Macassey in connection with the Cantyre scheme, but it was quite possible that some one else had tackled the same subject.

Mr. WALTER SMARTT asked whether there were any suitable ports on the west coast of Ireland. As to the construction of the tunnel, he thought it should be done by the Government, considering the great importance it would be for military purposes.

As a commercial undertaking he was afraid that for some time to come there would not be sufficient traffic to make it a success, but he had no doubt whatever that the tunnel, if made, would be of great advantage to Ireland.

Sir ROPER LETHBRIDGE said there could be no question as to the excellence of the ports. They had Galway and various other ports, which would undoubtedly be joined to the tunnel by lines of railway.

The EARL of DYSART asked whether there would not be a difficulty on account of the gauge. In Ireland the gauge was 5 ft. 3 in., which was not the same as in England.

Mr. BARTON said this difficulty could be obviated by putting down a third rail, which might be done at a very small cost.

Sir EDWARD WATKIN said the cost would be about £1,000 per mile.

The CHAIRMAN, in proposing a vote of thanks to Sir Roper Lethbridge, said he had been given to understand that anybody would easily make his fortune if he could do one of two things—either provide a specific remedy for baldness, or a specific remedy for sea sickness. Sir Roper Lethbridge had endeavoured to show that in the Irish Channel sea sickness might be done away with entirely by the scheme proposed. But putting that aside, he thought every one desired to promote the closer connection between England, Scotland, and Ireland. If the scheme were possible, it could not but result in great benefit to the sister Isle. The tunnel would not only be the means of bringing a large number of tourists into the country who were at the present deterred from going by the fear of the sea, but it would be the means of introducing a large amount of capital into the country. It would certainly have the advantage of promoting, to a very large extent, the great cattle industry which thrives in that country. Under proper supervision and care, he believed a tunnel might be constructed between Scotland and Ireland. At any rate, the paper would be the means of bringing the subject before the public and having it fairly discussed. One great difficulty in promoting all great undertakings was the preliminary expenses, but he hoped this difficulty would be overcome, and that if during the next ten or fifteen years a tunnel was built, those present that evening would remember that Sir Roper Lethbridge had been the means of arousing the public mind to the importance of the work.

Mr. WILLIAM JOHNSTON, M.P., seconded the

vote of thanks, remarking that he had always taken great interest in the subject of communication between England, Scotland, and Ireland by means of a tunnel. He was sure the discussion which had taken place that evening would tend to promote a scheme which, if carried out, would develop the resources of Ireland, and increase the prosperity of the British Empire. He also urged on the Chairman the importance of bringing the subject before the House of Lords.

The vote of thanks having been unanimously passed,

Sir ROPER LETHBRIDGE said it had been a very great pleasure to him to bring the subject forward. He ventured to express an earnest hope that, whatever might be the merits of the scheme, the Press would put it before the public, so that they could learn what was to be said on the general aspects of the scheme, and thus form an opinion upon it. If public opinion decided that the work should be done, it would be done in a very short time.

Miscellaneous.

THE TASMANIAN EXHIBITION.

The brilliant series of Australian exhibitions, though they were attended in each instance with large financial deficits, seem to have given full satisfaction to the various Governments upon which the losses fell, on account of the many direct and indirect benefits they brought with them. It is not therefore surprising to find the smallest of our colonies at the antipodes following the example of her wealthier and more important sisters, and announcing that an International Exhibition will be held by her, or that an earnest appeal to the mother country has been made to participate at this Exhibition. There appears, indeed, every reason why such an undertaking should benefit Tasmania as much, relatively, as Sydney or Melbourne. The value and importance of this small island are growing rapidly every year, and the recent development in the mineral wealth of the colony, is not only likely to increase its own revenues, but is drawing towards it from this country a large amount of capital for mining and other more purely industrial purposes. So that, even at the risk of incurring losses in the venture, Tasmania may feel herself fully justified in attempting an Exhibition, carried out as it will be under the direct patronage, and with the aid of the Governor and his Government.

The island of Tasmania, which lies to the south of the continent of Australia, and is removed from it

only by a distance covered by a few hours' steaming, is but 210 miles long, measured from north to south, and 200 miles from east to west; its total area is 26,215 square miles. Forming at one time a part of Australia, its leading physical features are two ranges of mountains running from north to south, and inclosing between them a wide stretch of fertile land; these ranges are, in fact, the continuation of the eastern Cordilleras of the continent, and afford ample proof that at one time the island was a part of the mainland. The coast line is bold and rocky, and is broken by the estuaries of numerous rivers, some of which are wide and deep enough for vessels of relatively large tonnage, and for considerable distances. The land is fertile to a marvellous degree, and the climate all that could be reasonably desired, the mean summer temperature being 62°, and that of winter 47°, while the average rainfall is 24 inches. The natural conditions being thus so favourable, there is little wonder that Tasmania is becoming every year a more favoured place of residence for the colonist, not only from this country, but from Australia. Of late years the remarkable discoveries of mineral wealth have added a still stronger inducement; on this point we shall have more to say presently.

The history of Tasmania, so far as this country is concerned, began in 1642, when it was discovered by Abel Jan Tasman, the famous Dutch explorer, who named what he considered to be a part of the mainland after Van Diemen, who was then the Governor of the Dutch East Indies. It was not till more than a century and a half had passed that an English voyager discovered the separating channel of Bass's Straits, six years before the island was taken possession of by England as a penal settlement; this was in 1803. Since then the history of Tasmania has been practically that of our other Australian possessions, the prosperity of which has been built up by the energy and determination of Englishmen. That its progress has been slower is due to absence of the gold fever that crowded so many districts of Australia with a population that brought but little credit or profit with them. The production of gold was recorded in Tasmanian official statistics in 1867, when 1,362 oz. were exported. Since that time gold mining has been a steady industry, though its importance has somewhat decreased during the past ten years; but the total figures remain, and are likely to remain, very considerable. With the exception of a few unimportant alluvial workings near the western coast, gold mining has hitherto been confined to the two great reefs of Beaconsfield and Lefroy. At the former, the workings which have been very successful, are carried out by the Tasmanian Gold Mining Company, which has absorbed several other ventures of less importance; this concern has paid considerably over half a million in dividends. The Lefroy reef, which gave great returns for several years, is not now the profitable undertaking that it has been; other very promising

reefs at Mount Lyall, near Mount Bischoff, and on the west coast, are at present almost untouched.

Tin was first worked in 1873, during which year four tons were produced. It occurs chiefly on the north-east coast, and at Bischoff, where the famous Bischoff Mines have paid over a million sterling in dividends. Although it had been known for many years that a wide distribution of coal existed in Tasmania, it is only during the last two years that coal mining has been carried out on an extensive scale. The present output is only about 40,000 tons a year, a quantity that could no doubt be increased indefinitely; nearly all the present production comes from the collieries at Fingall, worked by the Nicholls and Cornwall Companies.

The mineral enterprise which, however, is now attracting the greatest amount of interest in Tasmania is that of silver and lead. Great excitement, in fact, exists about this on the island, and during a very short time no less than 75,000 acres of claims have been taken up in 80-acre lots, near the mines; which, from all reports, will soon become famous. These mines are situated at Mount Zeehan, where two English companies are at work with very promising results. The completion of a line to the nearest port, in April next, will change the present conditions, and remove the difficulties about transport under which the companies at present labour, and when large extensions are contemplated. The extent of this silver region, so far as it is at present known, is about 8½ miles—from Mount Zeehan to Mount Dundas—but there are indications of a much larger area than this, and it is on this account that claims are now being taken up with so much confidence and rapidity.

Tasmania is a favourite summer resort for the holiday makers of Australia, and even of New Zealand, who flock there annually in crowds. For this reason, the contemplated Exhibition will possess much more than a local interest for exhibitors. From some cause, doubtless more interesting to the Tasmanians than to us, Launceston, and not Hobart, the capital, has been selected as the site for the Exhibition. It is not probable that many manufacturers in this country will send out goods on purpose, although, doubtless, it will pay some makers of mining and of agricultural machinery to do so. Still we believe that England will be well represented at this little show on the opposite side of the world, and for the following reason. The Melbourne and Sydney Exhibitions attracted many English exhibitors; and of these not a few established flourishing branches in Australia. It will be easy, and no doubt profitable, for such firms to exhibit, and the same reason holds good with a number of manufacturers in the United States; we believe that Canada intends to be officially represented, and that Austria has a sufficient market at the antipodes to induce a number of exhibitors to go from that country. It would therefore seem as though this little Exhibition is to be quite international, and

we are glad, in the interests of British trade, that this country is likely, for the reasons we have mentioned, to be to some extent represented. For the information of those manufacturers who may be desirous of obtaining further information, we may add that the Tasmanian Government has instructed their Agent-General, Sir Edward Braddon, K.C.M.G., to represent the interests of the Exhibition in this country, and that all communications on the subject should be addressed to him at 5, Victoria-street, Westminster.—*Engineering*.

Correspondence.

DECIMAL COINAGE.

The metric tables are to be met with side by side with the British weights and measures in all books where these usually obtain a place. The medical profession has virtually adopted it by force of necessity; for without it intercommunication with the profession in France or Germany would be impossible, and the study of the medical literature of these countries unintelligible. The metric system has for some years been taught in our medical schools, and is considered to be an important part of therapeutical knowledge. This intimate knowledge by the British mercantile and professional public we must acknowledge to be a very strong argument in favour of the adoption of this particular system for our weights and measures.

As regards our currency, the decimalisation of the existing coinage would not be a difficult matter; in fact, so simply might the present series of coins be converted from their present clumsy, irregular, and unsystematic arrangement into a perfect decimal system, that it is a matter of astonishment that the change has not been effected long ago.

In the pound sterling we have our standard of money. The tenth of the pound in nominal value is the silver florin, the 100th part of which would be a fraction slightly less in value than the present farthing; there being 96 farthings in the florin, and, consequently, 960 in the pound. So that, by dividing the pound into 1,000 instead of 960, and the florin into 100, instead of 96, we should have a perfect decimal coinage with very few changes in the existing coins. But it will be obvious that, by making the pound the integer and dividing it into 1,000 parts, three decimal places would be required for the fraction, thus: £53·250—53 pounds 250 farthings, which, in daily use, would become intolerable, as an article worth 6d. would require three figures to represent it, thus: £·025. In order, therefore, to obtain two decimal places

only for the fraction, by changing the position of the decimal point, and making the florin the integer, or acting unit, we might still retain the pound sterling as the standard, and obtain the same advantages as we should possess by using the pound as the integer, for we should be able to compute any sum in the familiar denomination pounds, if necessary, by simple "inspection," and without any arithmetical calculation. The nearest figure of the integer to the right hand representing florins, and the remaining figures to the left *always representing pounds*, thus: £53·250 now becomes fl. 532·50, and may be read as 53 pounds 2 florins 50 farthings.

In order to carry out this change, all that would be necessary would be to add four more farthings to the florin; that is, reduce very slightly the value of the bronze coins in order to make the farthing the 100th part of the florin instead of the 96th, the half-penny and penny representing, as formerly, two and four farthings; withdraw the threepenny piece from circulation, and introduce a new silver coin of similar size—a dime, or tenth, and representing ten farthings—of the value of about two and a half pence. A five-farthing piece could follow latter. The reduction in the value of the bronze coins, which are simply tokens, would be so slight as to be of little consequence to anyone. The crown and half-crown causing much confusion with the double-florin and florin, might with advantage be withdrawn from circulation. In order to cause no inconvenience to the Mint, until the new coins were issued, those to be changed, whilst in circulation, would represent their new values after the date specified (the 1st of January of any year) as follows:—The threepenny piece = twelve farthings, the penny = four, and the halfpenny = two; the crown and half-crown representing fl. 2·50 and fl. 1·25 respectively. The state of the coinage would be as follows:—

BRONZE—	Alternative Name.	Florins.
Farthing	(Cent).....	·01
Two farthings	Half-penny	·02
Four farthings	Penny	·04

SILVER—

Ten farthings.	Dime	·10
Quarter-florin	Half-shilling	·25
Half-florin ..	Shilling	·50
Florin	Two shillings.....	1·
Double florin.	Four shillings	2·

GOLD—

Five florins ..	Half-pound or Half-sovereign	5·
Ten florins ..	Pound or Sovereign.....	10·

For further particulars concerning this scheme, and the application of new money to old amounts, stamps, Government tariffs, &c., I beg to refer those interested in the subject to the February number of the *Chambers of Commerce Journal*.

W. WRIGHT HARDWICKE, M.D.

LITHOGRAPHY.

I must begin with an omission in Mr. Simpson's valuable paper of one who played a most important part in the introduction of lithography into London. I allude to Hullmandel, who for a long time played an isolated part—Hullmandel and Walton being comparatively modern. Hullmandel it was who essayed, with nearly all the artists and amateurs of his day—when lithography was killing a aquatint—'Gould's Birds' from stone replacing Audubon's plates. William Hunt, T. M. Baynes, and others worked with him. Mr. Simpson has dealt alone with stone, and told us nothing about zincography, that at one time ran chalk and ink work so closely as hardly to be distinguished from it. Zinc was unbreakable, extremely light, and could be granulated, but, at the same time, was very treacherous; and I remember to have lost many months of work at a single etching. In the days of lithography and the 'scraper' press, we had no idea that zinc would play such an important part in illustration as to constitute a revolution, aided as it is by the sun and the camera, in the production of relief blocks for printing by steam. As early as 1840, I essayed to make relief blocks by drawing upon zinc plates with acid-resisting substances in solution, but could not 'bite' them in to any depth, and, as printing then was done wet, and driven into the paper, the ground was apt to print. Stone has wonderful qualities, but there is one thing that it will always lack, and that is the brilliancy that is got by the graven line, that gives a relief upon the paper, or an indented line that sinks into the fabric. Louis Haghe well knew this, and in his skies and foregrounds produced tint stones that gave absolute relief, being so powerfully etched. The Hanharts have worked at lithography for three generations, being coeval with Hullmandel, Day owing his introduction to the art to chance, having a lithographic press left upon his premises that he thought he might utilise.

JOHN LEIGHTON.

Regretting that my friend, William Simpson, had to say "that there is some uncertainty about the introduction of lithography to London" (p. 193 of the *Journal*), I should be glad to refer him and others to the volumes of the "Repository of Arts, Literature, Fashions, Manufactures, &c," for April, 1817, issued by the celebrated publisher, R. Ackermann, 101, Strand. In volume iii., 2nd series, p. 222, is given "Some Account of the Art of Lithography, or Process for taking Fac-simile Impressions of Drawings from Stone." I will only here quote the last paragraph. "The lithographic art was brought over to this country in 1801 by M. André, of Offenbach, in its rude and original state. He published some specimens of different artists, but no improvement has since been made in it here. The admirable productions, however, which have of

late appeared at Munich, consisting as well of the works of modern artists as of imitations of ancient masters, for which lithography is peculiarly adapted, have excited a spirit of emulation in Mr. Ackermann, who is determined to use his best endeavours to rival the professors of this art on the continent. The annexed view, a drawing in chalk by Mr. Prout, exhibits an easy specimen of the productions of Ackermann's lithographic press. He hopes to have his arrangements in sufficient forwardness to employ the lithographic process in gratifying the public with further specimens on the 1st May next."

The specimen given is a view of "St. Elizabeth's Castle, Jersey," drawn by the well-known Samuel Prout, whom Ackermann greatly encouraged; and many of us may remember "Prout's Drawing-books," the predecessors of those by James Harding. The succeeding monthly numbers give specimens of the new art for ornamental work, fac-simile inscriptions, and other productions. In volume iv., p. 250, 1818, Ackermann announces that he "has in the press a translation from the German of the work by Mr. Aloys Senefelder, of Munich, illustrated;" this, I think, was published in that or the following year. Many succeeding numbers give examples, and the methods are explained of performing the work. Let England have the honour that is due to it for encouraging this art in its earliest stages.

WYATT PAPWORTH.

General Notes.

FRENCH RAILWAYS, ROADS, AND CANALS.—The last Bulletin of the Minister of Public Works gives the statistics of French railways, roads, and canals, for the year 1888. Summing up the conclusions to be derived from an analysis of the statistics, the Minister states that French railways, in 1888, while they increased their system in the proportion of 24 per cent. as compared with 1882, suffered a decrease of traffic to the extent of 4.1 per cent. in ton miles. The roads and waterways, without any practical increase in their amount (the increase in the extent of roads was 0.91 per cent., in waterways 2.2 per cent.), had an increase of traffic of 2.5 per cent. for the roads, and 40.4 per cent. for the waterways.

ALLIGATORS' TEETH.—Besides the hides of the alligator, of which 50,000 or 60,000 are annually utilised in the United States, there are other commercial products obtained. The teeth, which are round, white, and conical, and as long as two joints of an average finger, are mounted with gold or silver, and used for jewellery, trinkets, and for teething babies to play with. They are also carved into a variety of forms, such as whistles, buttons, and cane handles. This industry is carried on principally in

Florida. Among Chinese druggists there is a great demand for alligators' teeth, which are said to be powdered and administered as a remedy. As much as a dollar a piece is paid by them for fine teeth. All the teeth of the alligator are of the class of conical tusks, with no cutting or grinding apparatus, and hence the animal is forced to feed chiefly on carrion, which is ready prepared for his digestion. Other commercial products of the alligator are the oil and musk pods. The tail of an alligator of twelve feet in length, on boiling, furnishes from fifty to seventy pints of excellent oil, which, in Brazil, is used for lighting and in medicine. The oil has been recommended for the cure of quite a variety of diseases. It has a high reputation among the swampers as a remedy for rheumatism, being given both inwardly and outwardly. The crocodiles and alligators possess four musk glands, two situated in the groin and two in the throat, a little in advance of the fore legs. Sir Samuel Baker says they are much prized by the Arab women, who wear them strung like beads upon a necklace.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

FEBRUARY 18.—COL. SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S. "Methods and Processes of the Ordnance Survey." The ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

FEBRUARY 25.—E. J. RAVENSTEIN, "Colonisation and its Limitations." Sir RAWSON RAWSON, K.C.M.G., will preside.

MARCH 4.—J. HARRISON CARTER, "Modern Flour Milling." SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, will preside.

MARCH 11.—H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D., "Electricity in relation to the Human Body." W. H. PREECE, F.R.S., will preside.

MARCH 18.—F. H. CHEESEWRIGHT, "Harbours, Natural and Artificial." Lord ALFRED CHURCHILL will preside.

Papers for which no dates have as yet been fixed:—

"The Sources of Petroleum." By WM. TOPLEY, F.R.S.

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"The Use of Petroleum in Prime Motors." By WILLIAM ROBINSON.

"The Durability of Pictures Painted with Oils and Varnishes." By A. P. LAURIE.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock:—

FEBRUARY 17.—COMMANDER V. LOVETT CAMERON, C.B., "Chartered Companies in Africa."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

FEBRUARY 26.—ROBERT GORDON, M.Inst.C.E., "The Economic Development of Siam." SIR CHARLES EDWARD BERNARD, K.C.S.I., will preside.

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. the LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 30.—COL. J. O. HASTED, R.E., "The Perriar Project." The Right Hon. SIR MONTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, F.S.A., "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

POPULAR AFTERNOON LECTURES.

Friday afternoons, at half-past 4 o'clock:—
Captain ABNEY, C.B., D.C.L., F.R.S., "The Science of Colour."

February 13, 20, 27; March 6, 13.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

LECTURE I.—FEB. 16.—Importance of Transmission generally—Distinction between Live Power and Stored Power—Stored Power transmitted by Electricity and Air under pressure—Comparison between various ways of transmitting Stored Power—Cost of transmitting by Battery and Electromotor—Application to Trams.

LECTURE II.—FEB. 23.—Transmitting Live Power—Fundamental Principles—The Dynamo and Electromotor—Regulating Appliances—The Line—

Best section of Conductor—Cost of Plant and Working Expenses—Examples.

LECTURE III. —MARCH 2.—Limit of Distance to direct Current Transmission—Alternating Current Transmission — Synchronising Motors — Ferrari's Motors—Motors for Small Powers—Electric Machine Tools.

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

March 9, 16, 23.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 16 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Gisbert Kapp, "The Electric Transmission of Power." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. A. A. Hudson, "Recent Legislation as to Buildings and Streets in London."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. J. Starkie Gardner, "Wrought-Iron Works: The Mediæval Period."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albermarle-street, W., 4 p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m.

Prof. Orchard, "Agnosticism and its Tributaries."

London Institution, Finsbury-circus, E.C., 7 p.m.

Mr. W. A. Barrett, "English Folk Songs." (Illustrated.)

TUESDAY, FEB. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Foreign and Colonial Section.) Commander V. Lovett Cameron, "Chartered Companies in Africa."

Royal Institution, Albemarle-street, W., 5 p.m. Prof. V. Horsley, "The Structure and Functions of the Nervous System." (Part I.) "The Spinal Cord and Ganglia."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Messrs. Lewellyn B. and Claude W. Atkinson's paper, "Electric Mining-machinery."

Statistical, School of Mines, Jermyn-street, S.W., 7½ p.m. Dr. Arthur Newsholme, "The Vital Statistics of Peabody Buildings and other Artisans' and Labourers' Block Dwellings."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Prof. Howes, "Some Points in the Anatomy of the Crocodilian Skull." 2. Mr. R. H. Burne, "The Variation and Development of the Leporine Sternum." 3. Mr. Scott B. Wilson, (i.) "The Genus *Chasiempis*, with a Description of a new Species" (ii.) "Description of a new Species of the Genus *Himatione*."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. W. H. Corfield, "Sanitary Appliances."

WEDNESDAY, FEB. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Colonel Sir Charles Wilson, "Methods and Processes of the Ordnance Survey."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Charles Harding, "The Great Frost of 1890-1891." 2. Mr. H. F. Blanford, "The variations of the Rainfall at Cherrappoonjee, in the Khasi Hills, Assam." 3. Mr. T. W. Backhouse, "The Problem of Probable Error as applied to Machinery."

Microscopical, 20, Hanover-square, W., 8 p.m.

1. Dr. W. B. Benham, "*Eminia equatorialis*: a new Earthworm from Equatorial Africa."

2. Mr. T. B. Rosseter, "Cysticercus of *Tenia Coronula*, Duj."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Discussion on Mr. A. V. Newton's Paper, "The Teaching of the Law Courts." 2. Mr. E. Morton Daniel, "Patent Medicines." 3. Mr. P. Jensen, "A few Notes on the Patent office Library."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. M. Vining, "High-pressure Fire Mains."

THURSDAY, FEB. 19... Royal, Burlington-house, W., 4½ p.m. Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. G. C. Druce, "The *Dillenian Herbarium*." 2. Prof. Charles Stewart, "A Self-fertilising *Hemaphrodite Trout*." 3. Dr. John Lowe, "Some points in the Life, History, and Rate of Growth in Yew Tree."

Chemical, Burlington-house, W., 8 p.m. 1. Ballot for the Election of Fellows. 2. Prof. Perkin and Dr. Kipping, " α and Diactylpentane, Synthesis of Dimethyldihydroxyheptanethylene."

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. T. W. Rhys Davids, "Asoka, the first Emperor of India."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. Hubert Parry, "The position of Lulli, Purcell, and Scarlatti in the History of the Opera." With Musical Illustrations. (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Historical, 11, Chandos-street, W., 8½ p.m. Annual Meeting.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, FEB. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Popular Afternoon Lectures.) Captain Abney, "The Science of Colour." (Lecture II.)

United Service Inst., Whitehall-yard, S.W., 3 p.m. Captain Chas. Johnstone, "Manning the Fleet: A Re-arrangement of existing Corps and their Training."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. E. E. Klein, "Infectious Diseases, their Nature, Cause, and Mode of Spread."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. Wright Clarke, "Details of Plumbers' Work."

Philological, University College, W.C., 8 p.m. Prof. Rhys, "The Celts and the other Aryans of the P Group."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m. Annual Meeting.

North-East Coast Institution of Engineers and Ship-builders, Sunderland. 1. Mr. J. T. Nicolson, "The Strength of Boilers." 2. Mr. J. C. Spence, "Results of Experiments on the Strength of Boilers."

Geological, Burlington-house, W., 3 p.m. Annual Meeting.

SATURDAY, FEB. 21...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "The Forces of Cohesion." (Lecture II.)

Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.

Journal of the Society of Arts.

No. 1,996. Vol. XXXIX.

FRIDAY, FEBRUARY 20, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the course by Mr. GISBERT KAPP, on "The Electrical Transmission of Energy," was delivered on Monday last, the 16th instant.

Mr. Kapp discussed the various ways of transmitting potential energy, or, as he preferred to call it, for the purposes of these lectures, "stored power," and their comparative cost as opposed to that of transmitting "live power" by belts, gearing, or electric wires.

The lectures will be printed in the *Journal* during the summer recess.

POPULAR AFTERNOON LECTURES.

The first of a course of lectures on "The Science of Colour" was delivered by CAPTAIN ABNEY, C.B., F.R.S., on Friday, 13th instant.

The lecturer explained the fundamental principles of the science, and showed how colour arose by the absorption of some of the rays of the spectrum, leaving the remainder to produce on the eye the sensation of either a pure colour or a composite colour, as the case might be. He also explained the principles of "interference," and showed how colours were produced by its action.

The second lecture will be given to-day (Friday), at half-past four o'clock.

INTERNATIONAL CONGRESS OF HYGIENE.

The Council, acting on the recommendations of the Committees of the Indian Section and of the Foreign and Colonial Section, have

addressed communications to the Secretary of State for the Colonies, and the Secretary of State for India, urging upon them the importance of taking steps to secure the efficient representation of the Colonies and India at the Congress, which is to be held in August next, in London, under the presidency of H.R.H. the Prince of Wales.

INDIAN SECTION COMMITTEE.

The Committee met on 11th February, at 4 p.m. Present:—Major-Gen. Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Sir George Birdwood, K.C.I.E., C.S.I.; Sir Douglas Galton, K.C.B., F.R.S.; and W. Martin Wood; with Sir H. Trueman Wood, Secretary of the Society, and S. Digby, Secretary of the Section.

FOREIGN AND COLONIAL SECTION COMMITTEE.

The Committee met on 12th February, at 4 p.m. Present:—Sir F. Dillon Bell, K.C.M.G., C.B.; Sir Arthur Blyth, K.C.M.G., C.B.; B. Francis Cobb; Sir Saul Samuel, K.C.M.G., C.B.; Col. A. C. Hamilton, R.E.; C. M. Kennedy, C.B.; Sir Douglas Galton, K.C.B., F.R.S.; Admiral Sir Erasmus Ommanney, C.B., F.R.S.; Sir Edward Braddon, K.C.M.G.; Hyde Clark; Major-Gen. Sir Henry Green, K.C.S.I., C.B.; with Sir H. Trueman Wood, Secretary of the Society, and E. Cunliffe-Owen, C.M.G., Secretary of the Section.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, February 17, 1821; Colonel A. C. HAMILTON, R.E., in the chair.

The paper read was—

CHARTERED COMPANIES IN AFRICA.

By COMMANDER V. LOVETT-CAMERON, C.B.

It seems strange to me, as it must to many others here, that less than fifteen years ago the Prime Minister of England, while agreeing with me that Chartered Companies could, if it were possible to establish them, do much for civilisation and extension of commerce in the

less known parts of the world, should be of the opinion that, owing to the state of politics, it would be unwise, if not impossible, to advise the Crown to again give such powers to bodies of private persons. One reason alleged by the great statesman to whom I am referring was that such a grant would be bitterly opposed by the party then in Opposition, and that it would add to the difficulties inseparable from the carrying on of her Majesty's Government.

Strange was it also to those who heard this reason to see the first charter given to a company which conferred administrative and governing powers in recent times, granted when the very party whose opposition was then feared was in power, I mean the charter constituting the Borneo Company. The ice once broken, other charters, not only in this but also in other countries, followed apace, the Niger Company, the German East African Company, the British South African Company, and the Portuguese Mozambique Company. If I was premature in my proposals about chartered companies, I had been still more premature in my ideas on the subject, for constantly, in my journals written while in Africa, and in the letters I was able to send home, I find the same idea recurring, and even records of my conversations with some of the chiefs among the Arab traders whom I met, when I sounded them as to their willingness to accept service under such a corporation.

I was premature also, no doubt, when I spoke in this room, in 1876, on the commercial capabilities of Africa; when I also advocated the cause of chartered companies, though I must confess that apparently this ancient Society did not consider that I was, for among my most treasured possessions is the medal which was given me for that paper.

I was premature, no doubt, in thinking, while in Central Africa, that Africa could be of value to this country; and when in the very centre of Africa, in the midst of the richest and most fertile portion of the continent, proclaiming—subject to the approval of both Houses of Parliament—her Most Gracious Majesty's sovereignty over the river basins of the Nile, Congo, and Zambesi, the watersheds of which I was engaged in determining, so far as they were not included in the dominions of other recognised and sovereign states. The original of this proclamation is, I believe, still in the pigeon-holes of the Foreign-office, and it has at least once been quoted in Parliament.

Equally was I premature in 1876, in supposing that three millions sterling would be practically sufficient to strip the veil from those riches of Africa which I had partially revealed, and in believing that the political difficulties of opening up this continent, at once the oldest and newest, to the enterprise of these later days were greater than the physical. I am, of course, in this, only speaking of myself as being premature as regards general public opinion. Ismail Pasha, who, whatever his faults may have been, was possessed of high and lofty ideals, had the same opinions of Central Africa that I had, and had backed his opinion heavily in employing Baker, Gordon, and many others to push forward the limits of Egypt into the very heart of Africa; and perhaps nothing proves the correctness of his ideas more forcibly than the condition in which Emin Pasha and his followers were found by Mr. Stanley, after having been practically cut off from civilisation for so many years. I also only followed humbly in the footsteps of Burton (whose recent loss we all so deeply deplore), sharing the ideas of Livingstone and Bartle Frere, and I believe of all my predecessors in the task of African exploration; but I believe I may claim to have put the question of chartered companies, and of the benefit that might result to Africa, both as regards civilisation and commercial development, more clearly before the public than had been done before, and though I may not have had any hand in the actual obtaining of a charter, or of bringing into being any of the companies which have had charters granted to them, I think I may honestly claim to have had some influence in the movement which has rendered the existence of chartered companies possible in the end of the 19th century.

No doubt many will deny my claim. They are welcome to do so. I can show writings published in England and abroad, and bring many persons to prove that certainly I have constantly been advocating the establishment of chartered companies, and discussing the powers and privileges that should be conferred, and the restrictions which should be imposed upon them, as well as the duties they would be called upon to perform, and the advantages that they might properly expect to enjoy. Now though I may, perhaps, in some of the remarks I am going to make, seem in the opinion of some to criticise action more or less remote, I can assure you that I have no such idea. If any person feels himself aggrieved by what I

may say, I can only assure him that I am excessively sorry that he should apply to an individual or particular case remarks which were certainly only intended to apply to the general question.

I do not come here to-night to bless or to curse—I am not here as a Balaam, nor yet as a Balaam's ass—but simply to put before you the ideas I have on the subject of chartered companies, and perhaps more especially the restrictions by which they should be hedged round and prevented in any way—even though it may be involuntary—doing any harm to or trespassing upon the legitimate privileges of the natives; to insist that, as they intend to make a profit out of their undertakings, they shall in no way shirk their duties: and to point out how absolutely imperative it is that no native of the districts they administer should in any way suffer, in order that a favourable balance-sheet should be provided for the shareholders; and last, not least, that they should not only be content with keeping things quiet, but should insist upon the maintenance of law and order, and strive to lead those who may be placed under their care upwards and onwards in the path of civilisation.

If the responsibility upon those who accept the powers granted them by charter is great, still greater is the responsibility upon those who, in a constitutional country like ours, advise the grant in each special case. Firstly, they must consider the general principles of the control which the Government must exercise, and the points to which their attention should be specially directed in the exercise of this control; secondly, they must consider the manner in which this control must be exercised; thirdly, they must be careful in their selection of the persons to whom they entrust the exercise of this control; and, fourthly, they must be especially careful as to those to whom they entrust the great powers conferred by any charter; for, however perfect may be the control which they exercise, if these powers are granted to improper or unfit persons, they are certain to be wrongly used. The responsibility of a Government is in no way lessened, but rather increased, when they devolve any of their powers to a company, one of whose objects is the obtaining of pecuniary profits; and this is accentuated in the case where those placed under the jurisdiction of such a company are imperfectly civilised, and lacking in the means by which, in European countries, those governed have usually the

means of making known and removing the grievances under which they suffer.

Another responsibility which rests upon the Government which grants a charter to any among its subjects, is that of preventing those upon whom the privileges it may contain are conferred from using those privileges in such a manner as to conflict with the rights of their fellow subjects, or acting in such a manner as to involve the commonwealth, of which they are but a small portion, in political difficulties with other countries.

Those who accept the charter have a heavy responsibility as well as those that grant it, and in this responsibility every owner, if it be but of a single share, partakes with those who may be members of the board of directors, or by whatever name we may call the administrative council. Men may of their own free will, and for many reasons, some praiseworthy and some the reverse, abstain from exercising their political rights in their own country: in most cases they become possessed of those political rights without any special exertion on their own part, and if they do exercise them, do not exercise them (or should not if they do) for pecuniary profit. Every individual who invests in the shares of a chartered company does so of his own free will, and presumably with the hope of immediate or of ultimate profit; that they should profit by their spirit of enterprise, and by the employment of their capital, is perfectly right, but in so doing they accept the position of being rulers over their fellow men, and are immediately and directly responsible for any wrong which may be done to them. The native races, who are placed under the rule of a chartered company, are entirely in a different position from the servants of a railway or other industrial company; they are placed under a rule and laws without their free will being consulted, and have no means (save an open rebellion, which would almost certainly be suppressed, or of migration, which is in most cases impossible) of escaping from the effects of that rule and of those laws.

If the shareholders are under such a grave responsibility, that responsibility is intensified in the case of those forming the council of the society and of its officials. They must remember that though they have a duty towards their shareholders to render their investment profitable, they have other and higher duties towards those over whom they are permitted to rule, and towards the country by whom that permission is accorded. Towards those over whom they exercise authority, to see that

all their rights of person and property are regarded as sacred, to protect them from oppression, to provide for their progress in prosperity and civilisation, to ensure their true freedom, and to prevent their demoralisation, either by example or by ministering to the more depraved of their inclinations.

Towards the country by whose government the charter is granted, to keep its honour clean and unspotted, to avoid any course of action which may cause it expenditure either of blood or treasure, and refrain from any deeds which either directly or indirectly may lead to political complications with other civilised powers, to refrain from doing aught which may interfere with the valid rights of their fellow-subjects, and to maintain such a perfect distinction between their administrative and commercial expenditure and receipts that it may be possible at any moment to say so much is due to us for what we have done as to administration and civilisation, and so much represents our commercial assets; and even in this latter portion they should be able to say so much is purely commercial and so much is on account of public works of utility, which might possibly be regarded as being required in order that their administrative duties might be properly carried out.

To return to those who grant the charter, in a constitutional country they are the ministers of the Crown; but as the actual grant is an exercise of the Royal prerogative, the grant is not, as in most acts of such a grave nature, submitted to the approval of Parliament before it is made. The action of the ministers, no doubt, is liable to criticism for having advised the Sovereign to confer rights and privileges upon an individual or individuals, but once the charter has been granted, vested rights have been created, money is invested upon the faith of the continuance of the arrangements set up, and so many strong reasons for the non-revocation of the charter been called into existence by the mere fact of its being granted, that it is practically certain (except in abnormal cases, which are never likely to occur) that no action seriously questioning the conduct of ministers in such a case is likely to be taken, or, if taken, likely to succeed. For my own part, I think it would be a most excellent thing that, in future, powers such as now granted by Royal Charter should be conferred by Act of Parliament. Private bill legislation in this country, if somewhat costly, is conducted upon the fairest possible lines; some unnecessary talking there may be, but

still, a Committee of Parliament, and especially, I am told, of the House of Lords, is a most business-like body, and the *pros* and *cons* of such a measure would be thoroughly threshed out, while, at the time of the third reading, any interests which considered themselves injured would surely find a spokesman and have fair consideration from the whole house. Though, nominally, within the walls of St. Stephen's we have only the representatives of the inhabitants of the United Kingdom, still the relations of the voters who elect members to Parliament, and of the members themselves, are so wide and far reaching, that every subject of her Most Gracious Majesty (and many others beside) could always find some person who would be willing to bring before the notice of the House any grievance which is well founded, and which there is any hope of remedying.

As, however, this change has not been made, the ministers who undertake the heavy responsibility of advising the Sovereign to make the grant of the charter should in every possible way satisfy themselves that the grant will be not only for the advantage of those who apply for it, but that it will also benefit the whole British Empire, and especially those over whom the new Corporation will have rule and governance, and, furthermore, be absolutely certain of the validity of any concessions, the possession of which may form portion of the grounds upon which the demand for the charter is based.

As a general rule, it may be at once admitted that a company possessing powers such as are usually granted by Royal Charter will, under ordinary circumstances, be a benefit to the country at large, for it will at once stimulate trade and enterprise, thus adding to the wealth of the whole commercial community, and provide employment for the ever-increasing class who, while fairly educated and possessed of a spirit of enterprise, find it more and more difficult to find suitable employment, either in this country or the more settled portions of our older colonies. It may be urged that similar advantages might be obtained by making these new territories Crown colonies, but a moment's consideration will show us that this is not the case. A Crown colony, from its very constitution, and from its cost, entirely at first, and in a decreasing ratio afterwards, being defrayed by the British taxpayer, without any possibility of a direct pecuniary return, must be always conducted upon more or less timid and non-enterprising lines; the

efforts of its officials will ever be directed to keeping down the cost of government, and therefore, every new enterprise, and every possible extension of territory will be jealously regarded, and often prohibited, because of the immediate increase of expenditure entailed, so that future prosperity and security are sacrificed to the fancied necessity of showing a surplus in the annual balance-sheet. The chartered company, on the other hand, relieves the empire of all expense of administration from the very commencement, and looking upon its first expenditure as an investment of capital, is ever ready to promote fresh enterprises and extensions which, in the nearer or more remote future, may lead to great profits. These are two great advantages to the nation at large if and when the company is properly conducted; if a company is not properly conducted, however bright its prospects may be in the commencement, however great the natural riches of its territory, and the capabilities of its subjects, nothing but financial ruin awaits the investors, while the country, in order to remedy the mistakes that have been perpetrated, will find itself committed to heavy expenditure, and possibly to a series of costly and vexatious native wars.

As, therefore, the success or failure of the company affects the nation at large, and not only those who may be shareholders, and as this success or failure will be mainly dependent on the policy pursued by the directors, especially in the early days of the undertaking, the Ministers who are responsible for the grant of any charter should be thoroughly satisfied as to the competence of those to whom the grant is made to carry out the duties imposed upon them, and also to provide proper measures for ensuring an efficient supervision over them. We should, therefore, consider what people are those to whom these powers should be granted, and how a supervision over them may be maintained. Fortunately, in England, we are, in great measure through long heredity, a self-governing race; and also our experience is so world-wide, that there are many among us who have had experience in governing men of all sorts and conditions, and who have leisure time sufficient to enable them to give attention to matters of this kind. In the management of their estates, at quarter sessions, as Poor-law Guardians, as magistrates, as members of County Councils, as directors of railway and other companies, and as members of both Houses of Parliament, our nobles and gentlemen have a very large

experience in politics, in finance, in administration, and in government; and from among them I am glad to see that some of the chartered companies have found some of their most illustrious recruits. To these, to form an ideal council, should be joined men who have had experience in the colonies or India, in the naval, military, and diplomatic services of the Crown, and also men of high standing in the commercial and financial world, great merchants, bankers, and ship-owners.

In the finance side of the question, we must remember there is more than one sort of finance. There are members of what is generally termed *la haute finance*, men whose name is known throughout the civilised world, who are behind the scenes in all political questions; these men, or their nominees, would be valuable members of the council of a chartered company. There are the regular bankers, who pursue a steady and so-called legitimate business; among these, too, we may look both for investors and directors, men who are solid, substantial men of business. There are the ordinary investors, people who either look to a steady rate of interest on their money, or are (and in England these are an ever-increasing class) content to remain for periods more or less lengthened without any annual return, confident that, sooner or later, their patience and foresight will be rewarded, and they or their heirs reap a rich harvest, and that, if from some unforeseen circumstances, they may be obliged to part with their cherished investments, there will ever be found others of a like mind with themselves, who will be ready to pay a price which will not only recoup their original outlay, but will also provide a fair interest on it. If these were all in the financial world, the path both of the Government which grants a charter and of those who invest their capital in the undertaking would be comparatively simple. The Government would easily be satisfied as to those to whom the charter was granted being fit and proper persons, and the ordinary investor of the second class could remain in perfect quiet and security. But there is another class of financier which, while among its members it counts some men of the most undoubted character and most perfect honour, also includes men whose highest idea of honesty is that their actions should not bring them under the notice of the law, and who laugh over a sharp trick by which some unfortunate being has lost his all as a capital joke; who think the highest stroke of business is to float some

bogus company, by means of which they can gain some money for themselves, no matter at what cost of ruin to the widow and the orphan.

Now, in all new enterprises, this class of financier is almost necessarily engaged. The possession of special knowledge of the classes who are likely to interest themselves in such matters, the following of a *clientèle* on the Stock Exchange and elsewhere, these, and other qualifications of a like sort, and also a power of keen insight into the merits or demerits of a new undertaking, make their presence welcome, when their position, power, and influence have been honourably obtained. Some men know whether a business is really good or bad intuitively, and, exercising this power honestly, can always command the support of those who desire a comparatively safe, if somewhat speculative, investment. Others, whose powers of insight may be as keen, and their deductions as accurate, only care for any business on account of what they and their immediate following may realise by it. For its intrinsic value they care nothing, and often these men are mistaken by the public for those mentioned just before them. Below these there are other classes of promoters of companies, but it is of no use descending into these lower depths.

Now, when a chartered company is about to be formed (or any other new undertaking), men of this class of finance—good, bad, or indifferent—are sure to be about, trying in what way they, and those who follow them, may yet have a share in the good things going; in some cases, it may be men of this class of finance who set the movement on foot, and bring others into it. Men of this kind, who are successful, are always able to command large amounts of money, and to maintain a considerable appearance. If interested in the formation of a chartered company, there is no position which one of these men would more keenly desire than to be member of the Board, not for the salary, for that would not pay him for the time of one of his clerks, but because of the eminence to which it raises him both in the social and financial world. If the man is honourable, his satisfaction of his ambition is just and proper, but the Government, before permitting his membership, should make special inquiries, otherwise we may, in some future companies, see undue inflation of capital, the working of certain matters for the financial benefit of a group, and not for that of the body of shareholders in the company, nor

yet of the country and of its inhabitants which have been confided to their charge. The Government, therefore, in approving of members of the council, should in the future, as doubtless they have done in the past, perfectly satisfy themselves that no person sits at the council board of a chartered company who is not a person in every way qualified for that position. But beyond this, which has not yet been done, though the permanent members named in some charters are doubtless intended to fulfil the same purpose, there should be Government directors on the Board of each company, who should have a consultative voice and complete knowledge of the whole conduct of business, so that at any time when their colleagues were entering on any course which appeared to threaten danger to the country, or to menace the welfare or liberties of the subjects of the company, the Government might intervene, and if after careful examination it found sufficient cause, might advise the exercise of the right of veto. No ministry in this country would ever advise such an exercise of power without real cause; a body so powerful as a chartered company would have so many advocates in both Houses of Parliament, that any real or fancied injury inflicted on them would be promptly redressed.

Next we should look at the supervision of the officials of the company in those districts where they exercise power. Men may, from a false sense of duty and loyalty to their employers, so interpret rules and regulations, framed with the greatest care, as to cause hardship and injustice to uncivilised men over whom they have control, and, in order to obtain better pecuniary returns for the company, may be inclined to strain the regulations framed for their conduct. Such mistaken zeal is of course likely to be more or less condoned by their actual employers, and therefore Government should have the power to demand the dismissal or punishment of any official of the companies. In order to avoid, as much as possible, such cases occurring, the judicial and police officers should not have any dealing with revenue or commercial business of the company, beyond such as falls to the judges, magistrates, and police of any civilised country.

To insure satisfactory supervision, the Government must of course appoint officers for that purpose, and these should be selected for their ability and impartiality, and I think, in view of the many imperfections to which humanity is liable, that these officers should be

precluded from having any pecuniary interest, either direct or indirect, in the company (or in similar undertakings) over the action of whose *employés* they have to keep watch and ward.

One other precaution the Government should adopt, and that is to secure that, from the very commencement of the life of a chartered company, its administrative and commercial accounts should be kept entirely distinct and separate, so that when the time comes that Government of another kind has to be substituted for that by the company, there may be no difficulty in capitalising what is actually owed by the district over which the company has had control for administrative and public works, which, though not pecuniarily remunerative, have been for its benefit and that of its inhabitants, and placing this sum as a first charge against the new Government. Unless this is done, and done strictly and correctly, we shall be met with the same difficulty as confronted this country when the commercial and administrative functions of the H.E.I.C.S. were separated, and it was found impossible to say, with any approach to certainty, what sum was really due to the shareholders of the company for their capital expenditure in administration and public works; and only what Macaulay, in his splendid speech in support of the measure, called a compromise, could be arrived at.

That the capital expended in administration and public works should receive a higher interest than is paid on public debt (to which it is similar in character) in older and more civilised countries, goes without saying. There must be a certain amount of risk in these undertakings, and, as elsewhere, the extra risk must be compensated for by the possibility of higher returns. When the countries which have been developed by means of chartered companies become easily accessible, have a firm government justly administered, and their commercial prosperity assured, it will be easy enough, by a process of conversion, to reduce the charges on account of this *quasi*-national debt. In the granting of charters, the question of administrative capital, the interest thereon, and its ultimate conversion, should not, in my opinion, be lost sight of. In order to secure as perfect a division as possible between the commercial and administrative parts of a chartered company, it would be perhaps well that all the commercial undertakings, such as mines, trading companies, should be undertaken by subsidiary companies, the original chartered company only retaining in its own hands those

industrial undertakings (*e.g.*, railways, &c.) which in a new country can be most beneficially worked by the central power.

I have perhaps seemed to be speaking in a critical spirit, but I believe that on the lines indicated above chartered companies could reap ample returns for their original courage and spirit of enterprise, as well as for the capital risked, while the interests of the investing public, and of the natives of the countries concerned, will be efficiently guarded.

I have almost done. People may say—You have been speaking a great deal about the rights of the natives; is not all this governing them by chartered companies interfering with their rights? To these I would answer that, generally speaking, the condition of natives under the rule of their own chiefs is so wretched and uncertain, that any form of settled government must be an advantage to them; that without guidance and settled government they can never rise in the scale of civilisation, and that for large areas of Africa, and possibly other portions of the globe also, settled government and guidance can be best secured by means of chartered companies, without which these areas and their inhabitants would for many long years be left in state of savagery and misery, and the victims of oppression and wrong.

Chartered companies, properly controlled, form the proper medium between the praiseworthy and necessary caution of Government officials and the license which would arise if these new countries were to become the prey of adventurers, working simply for their own ends and profits. Charters also form a solid base of security for the capital invested in these new countries. In a word, chartered companies are a necessity of the time. They are powerful instruments for good. They should be an advantage to the country which grants them, and also to the countries they may rule. No other instrument yet devised is so powerful for good, therefore, to all we may wish success and prosperity, so long as those who are responsible for their conduct act with wisdom and generosity. As they are powerful for good, so also, if maladministered, they may become instruments for evil; and this will be the case if their shares are counted by the owners simply as so many counters with which to take part in the fascinating game of Bourse operations. I wish each and every chartered company that does its duty the most ample success imaginable.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said the paper had very clearly laid down the requirements in governing bodies of chartered companies, and had made very useful suggestions as to their selection; and it had then gone on to recommend three specific reforms in future charters:—1. That permanent members of the council should be appointed by the Government, who should have no interest in the company. 2. That the Government should have the power of dismissing officials, which, no doubt, would be an advantage to the countries governed; and he did not see why it should be objected to, as such a power would never be exercised unfairly. 3. That the administrative and commercial accounts should be kept separate. The concluding recommendation was, that mining and other operations should be entrusted to subsidiary councils, which would no doubt be advantageous, as each one, having one specific object to attend to, would be able to do so more efficiently than the governing body which had to administer the whole country.

Mr. MURRAY said all who had paid any attention to African affairs knew how much they owed to such men as Commander Cameron, who, by their bravery, self-denial, and energy, had extended the interests of the Empire towards what was called the "Dark Continent." Commander Cameron, in his travels through Africa, had learned how necessary it was that there should be some guiding power over the hordes of natives; and any one who looked into the history of the matter would see that there had been two powers more or less connected with Africa—one an historic power, and the other a practical one. One had raised the natives to a better condition, the other had simply pillaged them and left them poorer than ever. A warning had been uttered against what he should call stockjobbing, but he thought the Governments were quite able to judge who were fit to be members of these councils. From some knowledge of the way in which two chartered companies had been constituted, he thought every one of the conditions which Commander Cameron laid down had been enforced, and Government nominees were on the Boards. If the empire were to be extended and developed it must be in one of two ways—either by the Government direct, or by falling back on the old lines of Raleigh and Drake, who discovered places which could be developed, and were backed by money subscribed by the merchant princes of these days. Just now we seem to have gone back to this old plan, and he believed the merchant princes of London to-day were doing their work as honestly and loyally as in the grand old days of which they had all read. He did not know where the next chartered company was to operate, for the world was growing very small, and there was not much spare room left to work upon. If there were new

companies established, however, he hoped it would be on the lines which had been laid down.

Mr. HYDE CLARKE congratulated Commander Cameron on having this opportunity of vindicating the claim he put forward in his paper, which was certainly well founded, for he was one of the first to advocate chartered companies in Africa. It was with that view that the African Section of the Society was established, at the suggestion of Sir Erasmus Ommanney and himself, with the permission of the Council, and he would point out how great was the contrast between the state of things at that time and now. Then it was impossible to make any impression either on the Government or on the public but through the efforts of that Section, and through the work which it did in obtaining the assistance of such men as Commander Cameron. Now, instead of doubting whether it was possible that a chartered company should or ought to be formed for Africa, the stage of criticism had been reached. He must say that he differed on some points from his gallant friend, who seemed to have a great preference for Acts of Parliament instead of a Royal Charter. He feared that during the long time he was in Africa he had not been very well supplied with newspapers, and that he indulged in rather too much ideal admiration for private Bill legislation. There was every reason to be satisfied that successive Governments had granted these charters, and he had been a little surprised at the warning which had been given with regard to Stock Exchange troubles and speculative schemers, for, so far as he was aware, there had been no openings yet for any of these people in connection with these great companies. On the contrary, the Government had acted on the lines he had laid down, and there was every reason to be satisfied with the men to whom the guidance of these great companies had been confided. He was not quite prepared either to adopt his dictum with regard to Crown Colonies, because they were not entirely dependent on Downing-street. After a certain time you either got some able and enterprising men as governors, men who left their mark on the history of the empire, or a council, legislative or executive, of the inhabitants, and they were on the lookout for every opportunity of developing new industries, and extending their operations. This, however, had not much relation to the real argument, because Commander Cameron had laid down, as he did years ago, that chartered companies were well qualified to carry out the objects he had in view. At the present moment they were greatly dependent on the three great African companies for the maintenance of English influence in Africa. He quite concurred with what had been said as to the rights of the natives, and he might have gone further, because he knew practically what the real rights of the natives were—the right of being slain and oppressed in the most abominable manner by slave hunters, by Portuguese, and by their own brethren, more particularly the Zulus. The one

prominent fact in the history of Africa was that within a comparatively late period the Kaffirs or Zulus had advanced over the greater part of Africa, until their language was now to be found even on the north-east coast. Under the chartered company carried on in the way described, therefore, the natives really for the first time acquired any rights worth having. Commander Cameron was much to be congratulated on being able to come forward and show that in this instance his labours on behalf of Africa had had a really practical result.

Mr. WALKER said he had been connected for eight years with a chartered company in Borneo. There the method of developing the resources of the country by means of subsidiary companies had already been carried out to a large extent, for there were twenty-five or thirty such companies in London in existence, and their capital was perhaps three times that of the parent company. The statistics of imports and exports showed what had been done. Ten years ago the total was about £25,000, whilst in 1890 it had grown to £500,000. It seemed to him very unnecessary to have a Government representative on the Board. These Boards were of the highest character; amongst the members might be found statesmen, colonists of high standing, naval men, merchants, and bankers, and he thought they might be fairly left to control the action of their own company. Again, as to the suggestion that the Government should have the power of dismissing the servants of the company, that seemed to be somewhat vague. In Borneo there were three protected States, one of which was under a chartered company. These were all under British protection, and under the immediate supervision of the Governor of Singapore, who could take exception to any action which occurred in those districts. This was provided for in the charter of the company. He also thought it very unnecessary to ask for Parliamentary interference, because the charters hitherto granted had been thoroughly well considered, as was proved by the fact that the original charter granted to the British North Borneo Company had been repeated in the subsequent cases. This was quite sufficient to show that it had received due consideration, and had been approved by the men best capable of considering the subject.

The CHAIRMAN then proposed a vote of thanks to Commander Cameron for his interesting paper, which was carried unanimously.

Commander CAMERON, in reply, said that it probably did not make much difference in actual working whether the charter was granted by Act of Parliament or by the exercise of the Royal prerogative, because it was always open to review the conduct of a minister. But still there was the possibility that a charter might be granted after the close of the Session, a general election might take place before the next, and the minister responsible for the charter might then be out of office, and there would

be no means of calling him to account. He did not hear much about private Bill legislation when in Africa, but he knew something about it generally; and whilst no doubt there was some difficulty connected with it, he always understood it was not unfair as a rule. When speaking of subsidiary companies, he was thinking of the Borneo Company, because he knew what had taken place there, and hoped the same course would be followed by the younger companies in Africa. With regard to the question of Government representatives on the Board, if it was thought necessary to have a Government director on guaranteed Indian railways, where the responsibility was limited to a guarantee of 5 per cent., it was much more so in the case of chartered companies, who might have to deal with the lives and liberties of thousands and thousands of native Africans. He thought it was necessary that Government should have absolute knowledge of what was being done, looking to the serious nature of the delegated responsibility, for a delegated responsibility was even greater than one undertaken directly. There should, therefore, be absolute knowledge on the part of the representatives of the Government of what was being done—not necessarily to be revealed to the public but for the use of the executive Government—so that it might step in at once, and stop anything which might possibly lead to wrong doing. Very likely the high officials in these councils might be misled. They might not know, and in fact could not know, and ought not to know all the interior political life of the Government, and there should be some immediate and direct means by which the Government should know what they were doing, in order to prevent any breaking of the intricate clockwork of diplomacy. The Boards of these chartered companies could not be informed of the negotiations the foreign minister was carrying on, or there would soon be an end of all secrecy and diplomacy; and, therefore, there ought to be some absolute and safe means for making the Government acquainted with what was going on. These official members would of course be appointed simply to represent in a friendly way the views of the Government, and to report to the Secretary of State, with whom the primary responsibility must always rest.

ELEVENTH ORDINARY MEETING.

Wednesday, February 18th, 1891; the ATTORNEY-GENERAL, M.P., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Agius, Edward Tancred, 52, Belsize-park-gardens, N.W.

Bedford, Major-General Joseph Herbert, Avenue-house, South Norwood-park, S.E.

Brooks, Samuel, Park-corner, Redhill, Surrey.
 Cotton, George, Byculla-club, Bombay.
 Day, Frederick Frampton, 16, Staining-lane, S.E.
 Lovibond, Valentine Locke, The Hermitage, Lillie-road, Fulham, S.W.
 Sabine, Alfred, Grasmead, Underhill-road, Honor Oak, S.E.
 Schlesinger, Harry Adrian, Glenhurst, Coventry-road, Ilford, Essex.

The following candidates were balloted for, and duly elected members of the Society:—

Brumleu, William Charles, 7, Mincing-lane, E.C.
 Carpenter, Charles Claude, Bridge Foot, Vauxhall, S.E.
 Coxeter, Samuel J., Woodlands, Gloucester-road, New Barnet.
 Petit, Hon. Sir Dinshaw Manockjee, Petit-hall, Malabar-hill, Bombay.
 Piper, Edward Jesse, Rose-cottage, Sidcup, Kent.
 Richards, William Armstrong, Hillside, Sandbach, Cheshire.

The paper read was—

METHODS AND PROCESSES OF THE ORDNANCE SURVEY.

BY COLONEL SIR CHARLES WILSON,
K.C.B., K.C.M.G., F.R.S.

In 1791, just a century ago, a trigonometrical survey of the country was ordered for the purpose of producing a military map; and in 1797 it was decided to publish a general map of the kingdom, founded upon a minute survey. This map was on a scale of one inch to a mile, and the first sheet was published on the 1st January, 1801.

In 1824, this survey was partially suspended, in order that Ireland might be surveyed on a scale of six inches to a mile, for a general land valuation. In 1840, the survey of Ireland being almost completed, and the 6-inch plans having proved to be of great practical value, H.M. Government decided to continue the survey of Great Britain on the 6-inch scale instead of on the 1-inch. This order continued in force until 1851, when there commenced a Parliamentary struggle, which has not inaptly been called the "battle of the scales." The battle lasted nearly twelve years, during which period one Royal Commission and three Select Committees of the House of Commons reported their views upon the scale most suitable for a national map. The 6-inch scale was stopped, and the 1-inch reverted to; then the 6-inch scale was ordered again. For fifteen months the Director-General had no

orders as to scale; in 1857, Parliament sanctioned the adoption of the 25-inch scale, and in the next year refused the money to carry it out. The Survey Department was disorganised, the public were dissatisfied, and a sum of £30,000 was absolutely wasted during the progress of the battle.

Finally, in 1863, it was definitely laid down that the under-mentioned plans and maps were to be published:—

1. Town plans, on a scale of $\frac{1}{5000}$, or 126·72 inches to a mile (commonly called the 10-foot scale), of all towns with more than 4,000 inhabitants.

2. Parish plans, on a scale of $\frac{1}{25000}$, or 25·344 inches to a mile (the 25-inch scale), of the cultivated ground in all counties.

3. County maps, on a scale of $\frac{1}{100000}$, or 6 inches to a mile.

4. A topographical map, on a scale of $\frac{1}{62500}$, or 1 inch to a mile, in two forms: one in outline, with contours only; the other with the hill features.

5. Map of the United Kingdom, on the scale of 4 miles to the inch.

6. Map of the United Kingdom, on the scale of 10 miles to the inch.

Since 1863, the only changes of consequence that have taken place are:—The authorisation, in 1872, of a new 1-inch map of England and Wales, based upon the cadastral survey; the issue of authority to revise the maps of Great Britain in 1886; and the order, issued in 1887, to publish Ireland on the $\frac{1}{25000}$ scale.

I do not propose, on the present occasion, to describe the measurement of the base lines, and the operations connected with the principal triangulation and the levelling of the country. But I would point out that the scientific work of the survey, which was at one time equal to, if not superior, to that of Continental countries, has, in consequence of the pressure to complete the cadastral map, been for some years in abeyance. Nearly all other countries have re-measured the angles of their principal triangulation, and re-levelled their main lines of levels with the more perfect instruments of the present day. England should do the same. It is most desirable, in the interests of science, that the angles of the principal triangulation should be re-measured, and the main lines of levels re-levelled with improved instruments; that there should be new tidal observations, with the best self-registering instruments; that pendulum operations should be conducted at selected stations; and that the differences of longitude between certain points should be

determined with greater accuracy than they are at present. I hope that the scientific work may some day be resumed, but, as it is not necessary for the revision of the plans, I fear there may be much difficulty in obtaining the requisite money.

The 25-inch or cadastral survey of this country differs from similar surveys in foreign countries, in that it is directly based upon the triangulation. The chain surveyors work in the tertiary triangles, whose sides average $1\frac{1}{2}$ miles in length, and all details are fixed by rigid measurement with the chain; the limit of error allowed is two links in 1,000. Errors cannot be entirely excluded, but, on the whole, the British survey may claim to be the most mathematically accurate in Europe. All maps on smaller scales are reduced from the 25-inch map, which is called the parent map.

The field work of the survey consists, at present, of the re-survey of Yorkshire, Lancashire, and Ireland, on the 25-inch scale, they having been originally surveyed on the 6-inch scale, only; the revision and re-survey of the towns in Ireland, and in the two English counties; and the survey of new London.

In carrying out this work, the original 6-inch survey is largely utilised; the detail is plotted from the old field books, and tracings of the outline are then made on tracing paper of a convenient size for examination in the field. On these traces buildings are outlined in red, streams and water in blue, other detail in black. The "Examiners" supply all new detail on the tracings, and obliterate that which is obsolete; they define roads as main, parish, or occupation; indicate whether buildings are of masonry, iron, or wood, supply names, and test generally the correctness of the boundaries. A final examiner goes over the work of each party of examiners, and is responsible for its accuracy.

In several districts, however, especially in South Lancashire and Yorkshire, and in the west of Ireland, it has not been possible to utilise the old survey; in the one case owing to the great change in the artificial features of the country, in the other to the want of completeness in the original survey, which was made for a Townland valuation. In these districts a re-survey on the larger scale has been found necessary.

The tracing supplied to the "Examiners" is returned to the division office when completed, a draughtsman then transfers all the corrections to the plotted plan, and afterwards pens in all outline, colours the buildings and water,

&c. All ornament, trees, furze, shingle, and rough pasture are stamped on the plans, and all names are typed. As the plans are reproduced by photography, all lines are made as black and sharp as possible. After the drawn plan has been thoroughly scrutinised by a "plan examiner," it is examined on the ground by the division officer.

The area of each enclosure is then computed and written down in a book of reference for examination at head-quarters. Each enclosure has a separate number, the numbers running consecutively through the parish.

At this stage the plans are sent to the levelling division for the insertion of bench marks and levels; and they are afterwards forwarded to head-quarters, Southampton, where they undergo a thorough scrutiny as to execution, agreement with the tracings and other documents, and general conformity to survey usage. The areas of the parcels are again computed and tested, and the plans are then returned to the division officer, with a list of remarks which may have arisen during their examination. On the return of the plans from the division, with the remarks attended to, the acreages are stamped underneath the parcel numbers, and the work is then forwarded for publication.

There is a wide difference between the practice of this country, in regard to the publication of large scale plans, and that of foreign countries. In the United Kingdom the town and cadastral plans are published, and sold at prices which are intended to cover the cost of publication. In foreign countries the plans are, as a rule, kept in MS., and copies, either tracings or lithographs, are supplied at the cost of the applicant; they are only published when necessary for special purposes, or to meet some particular demand. The publication of the English plans was authorised under the expectation that the plans would be largely utilised for administrative purposes and by owners and occupiers of land; and that there would be no difficulty in selling out an edition, and so recouping the cost of publication.

Owing chiefly to the policy that has been adopted with regard to the sale of the maps, and to the ignorance of their existence in country districts, this expectation has not been fulfilled. In some cases sheets have run to two and three editions, but in a very large number of instances only two or three copies out of an edition have been sold. The labour entailed by the publication of these large scale

plans has been enormous, and very much beyond anything that the survey departments of other countries have been called upon to undertake. Their production and publication has been the real work of the Ordnance Survey Department during the last thirty years, rather than the production of maps on smaller scales.

Up to 1853, all Ordnance Survey maps were engraved on copper; but, in 1854, lithography was adopted for the $\frac{1}{62500}$ and $\frac{1}{25000}$ scales. This was soon displaced by zincography, which has in turn, since 1889, given place to photo-zincography. The art of printing a line photograph in permanent ink from a zinc plate, or photo-zincography, was discovered in 1859, but excepting for the reproduction of national MS., no practical use was made of the discovery until 1881, when the process superseded engraving for the production of the 6-inch map. To obtain the full advantages of the process, the MS. $\frac{1}{25000}$ plans were drawn in a style suitable for reduction, *i.e.*, the buildings were coloured yellow to reproduce black, and the names, ornament, numerals, &c., were exaggerated so that their reduction might be of the proper size. This arrangement had its disadvantages. The $\frac{1}{25000}$, or parent map, still continued to be published by zincography, and was really sacrificed to its offspring, the 6-inch map, which was published months in advance of its parent. It also ruined the drawing which was formerly so much admired, for the draughtsmen, realising that their efforts were only directed to the preparation of a groundwork for a mechanically-reduced map, lost interest in their work. In Ireland, however, where photo-zincography has never been introduced, the MS. plans continued to be very beautiful works of art. Photo-zincography has now been adopted for the publication of all new plans on the $\frac{1}{62500}$ and $\frac{1}{25000}$ scales, with the following advantages:—Fidelity of reproduction of the original; saving of cost in the case of close work; acceleration of publication; uniformity of execution; great improvement in the style of original drawing; and facility in revising town plans. The parent plan has also resumed its proper place in the publication in advance of the 6-inch map.

The photo-zinc process is so well known that I need not describe it here, except to point out the large scale upon which photocopying is being carried out by the Ordnance Survey Department. The glass plates measure 45" X 30", and weigh 33 lbs. The paper used for the photo-transfers is Evans' thin paper; and it might be thought that a system of

photographic reproduction, based on a flimsy paper transfer, would introduce many elements of inaccuracy. In practice, however, the process is found to compare favourably, as regards accuracy, with zinc etching methods, and engraving on stone or copper. Impressions varying more than one-sixth per cent. from the true scale are now cancelled. This result is very largely due to the skill that has been acquired by the photographic and printing staff.

The following method has recently been adopted for producing the $\frac{1}{25000}$ plans of large towns from the $\frac{1}{62500}$ plans:—A convenient number of $\frac{1}{62500}$ plans are pinned together, and a negative of the reduction obtained in the usual way. From this negative a cyanotype print is obtained, the result being a pale blue image on a white ground. The necessary drawing is now proceeded with on the cyanotype, and, when complete, it is fixed in its proper position with the surrounding $\frac{1}{25000}$ detail, and then re-photographed for publication.

The maps are now printed by a specially designed steam zinc plate printing machine, which, when necessary, can print 900 impressions an hour.

The 6-inch scale.—Until 1881, the 6-inch map was engraved on copper, the reduced detail being obtained from the $\frac{1}{25000}$ map by photography. In 1881 it was decided to abandon engraving in favour of photozincography, and the practice was to pin four $\frac{1}{25000}$ sheets together with their proper margin, and reduce them at once to a quarter sheet.

The present system is to take a blue impression of each $\frac{1}{25000}$ sheet as it is being printed for publication, and upon this to pen in to scale all detail that is to appear on the 6-inch map, in black, whilst the names, ornament, trees, numerals, &c., are typed in an exaggerated style, so as to be of suitable size when reduced. All parcel and area numbers and unimportant detail are not penned in, and, being in blue, do not photograph. Four such plans, forming a 6-inch quarter sheet, are placed together and reduced at once by photography. The parks, mud, and sand are inserted in a tint by transfer from copper after the photo-transfer has been laid down on zinc.

The 6-inch quarter sheet was adopted partly for convenience, the size being much more handy than that of the full sheet, and partly for acceleration of publication, for a quarter sheet can be published as soon as the four

component $\frac{1}{2500}$ plans are received, without waiting for the other twelve.

It may be mentioned that, as an experiment, sixteen $\frac{1}{2500}$ plans were placed in position on a screen with the proper margins, and a full 6-inch sheet produced from them in one operation. There was a slight distortion towards the corners, but I believe this may eventually be overcome.

The 1-inch Map.—The M.S. map on the scale of 1 inch to a mile is produced from the 6-inch maps by the aid of photography. The 6-inch map is printed in light blue ink, and the detail that is to appear on the 1-inch map is then penned in with black ink. By this means only the details in black appear on the reduced photograph which is used by the engraver. This reduction also gives the index map to the $\frac{1}{2500}$ sheets in a 6-inch sheet, which, by the use of stencil plates, we are able to sell coloured for 2d.

One of the most troublesome details we have to deal with in producing the 1-inch map is the selection of the names and artificial features that are to appear on the smaller scale. In the old 1-inch map this difficulty did not occur, for the survey was made on the 1-inch or 2-inch scale, and the surveyors only showed those features that could properly be represented on that scale. The old 1-inch was also a military map, and details not of military importance were omitted. The new 1-inch map is produced by more or less mechanical reduction from the 25-inch plans, by men who have no personal knowledge of the details on the ground. This led at first to the occasional omission of detail, such as clumps of trees, which though very prominent on the ground did not appear to be so on the large scale map. To meet this difficulty, prints from the reduced photographs are now examined on the ground by highly-trained men, who eliminate unimportant detail, and add important features that have accidentally been omitted during the process of reduction. The prints are also examined on the ground in a more general manner, by an officer, and the names that are to appear on the 1-inch map are also checked by an officer.

In this manner we try to ensure accuracy, and avoid overcrowding of detail and names, and I think the sheets that have been published during the last year will bear comparison with the maps of any country. It must be remembered, in comparing the English 1-inch map with the maps of other countries, that whilst the latter, on scales analogous to

the one inch, are military maps, the military character of the one-inch map has had to give way to the civil requirements of the State. There is, too, no country in the world which is so covered with artificial features, houses, roads, railroads, &c., as England; and the representation of even a selection of these must overcrowd a map on a small scale. There are, it may be remarked, quite as many complaints of omissions as of overcrowding, and features which some people consider to largely enhance the value of the map, are denounced by others as useless and disfiguring.

The old system of engraving the 1-inch map was in the first place to engrave all the outline and writing upon a plate of mercantile copper. A matrix was then taken by the electrotype process, and from this a duplicate copper plate was made, upon which the contours were engraved. This plate was used for printing the copies sold in outline, without the hill features. The hill features were then added to the original plate. This system had one great disadvantage, that whenever a new railroad or road was inserted on the plate, the hills were damaged, and had to be repaired at great cost, but it had the advantage of requiring only a single printing. The introduction of the steam copperplate press has enabled us to bring the following system into use. All the outline, including the contours, is now engraved on one plate, and the hills on another; and the hill impressions are produced by double printing. The hill plate will now never require repairing, and will always preserve the character given to it by the original engraver. It is also possible to print the hills in any colour.

Line engraving is a very slow process, and it is difficult to find engravers with sufficient skill and artistic taste to engrave the hill features on the 1-inch map. We have, therefore, for the last two years been trying to discover some more rapid process, and one that should combine on the same map the mathematical accuracy of the contours, with the pictorial effect of hill shading. We have, unfortunately, only been successful to a certain extent, but the difficulty seems to have been overcome by a German publisher, Herr Petters, who has produced a very good result from one of the brush drawings of the 1-inch map.

The question of colour printing has also been considered, and two 1-inch sheets have been published in outline; but there has been practically no sale of them, and until a demand arises no more will be published.

The processes of the survey were described in great detail, in a series of papers communicated to *Engineering* in 1888 by Captain Sankey, R.E., to which I would refer those who are interested in them. A very good general account—of which I have largely availed myself—is contained in a lecture given by Major Washington, R.E., at the School of Military Engineering, Chatham.

There are some points connected with the survey to which attention may be drawn.

The revision of the survey has unfortunately fallen very much in arrear, so much so, in fact, that in many places revision means a re-survey. The necessity for a revision has frequently been pointed out by the officers who have had charge of the survey; but it was not authorised until December, 1886; and since that date the department has been fully occupied in placing Lancashire and Yorkshire on the large scale, and in bringing out new plans of the towns in the two counties. The question of revision is purely one of money. It is, I think, hardly possible for the Survey Department, with its present staff, ever to overtake the heavy arrears, and get the map of the country into a normal state; but those arrears once cleared off, it would be a simple matter to revise the country once every 15 years, and town districts oftener.

In view of a periodical revision, I have roughly divided the kingdom into revision districts, and as opportunity offers I am moving the division offices into centres, which will probably be permanent. Thus, the division officer at York will, when the large scale survey is finished, be given a district comprising Yorkshire and other counties, and will be responsible that the plans of his district are kept fairly up to date. I propose to invite the surveyors of the large towns to place themselves in communication with the division officer, and to inform him annually of extensive improvements or additions. These would be surveyed every two or three years, and transferred to the large negatives which are kept at Southampton. In this manner the plans of the large towns would be kept well up to date. The plan I am adopting will allow no new work to fall into arrear; the time when old arrears will be cleared off depends entirely upon the annual grant to the survey.

The re-survey of Lancashire and Yorkshire has brought to light the great changes that have taken place during the forty years that have elapsed since the original survey. The

town area has increased from 80,389 to about 120,000 acres, and this necessitates more than 1,000 additional town plans. In South Lancashire and South Yorkshire the face of the country has been altered to an extraordinary degree. On the east coast of Yorkshire the sea has encroached upon the land about 215 feet; and in the coal districts there has been a general subsidence of the surface over large areas. The area of London has nearly doubled, and the survey of the new quarters is in itself a work of great magnitude.

The question of revising the Ordnance Survey plans is thus a much larger and more complicated one than is generally supposed. There are not only many economical difficulties connected with the field work but also with the reproduction of the plans. For instance, in many districts an entirely new series of MS. plans will have to be drawn; in others there will be numerous changes in minor detail which will not necessitate new plans, but which should appear on impressions issued after the revision has taken place. The publication of a revised plan means the cancelling of all old impressions in store, a rather costly process.

In the utilisation of the Ordnance Survey maps the Irish Government is quite 25, if not 50, years in advance of England. In Ireland townland boundaries and areas, as ascertained and shown upon the Ordnance Survey maps, are the legal boundaries and areas of the townlands, and they can only be altered with the sanction of the Lord Lieutenant and Privy Council of Ireland. As there are rather more than 62,000 townlands in Ireland, averaging a little over 300 acres each, it will be seen that that country contains a large number of small, practicable, and well defined lines, from which all other divisions, such as parishes, baronies, counties, unions, and electoral divisions can be built up. Disputes as to townland boundaries are unknown.

The Irish Valuation Acts provide that the Ordnance Survey maps are to be used in ascertaining the areas of tenements, and a very good system of valuation is in force. The boundaries of the several holdings were marked on the Ordnance Survey maps, and the areas were then computed from the maps. The sum of the holdings was made to agree with the legal area of the townland shown on the Ordnance Survey maps. The cost of the original tenement valuation was 3½d. per acre, or £10 a square mile, and this included the marking of the tenement boun-

daries on the ordnance maps; the computation of the areas; the valuation of the land, buildings, and all other property; the settlement of appeals; and the issue of final lists for rating purposes. The time occupied in each county from the commencement of the valuation to the issue of the valuation list was about two years.

In Ireland, too, all land is sold in the Land Judges' Court by the aid of maps prepared by the Ordnance Survey, and all maps on title deeds are drawn by the Department.

In England the case is very different. There is a special Boundary Division charged with the ascertainment of boundaries, which prepares elaborate reports and maps of all boundaries; and the area of every parcel is accurately computed. Yet the boundaries and areas on the Ordnance Survey maps are not legal, and the maps are very rarely used for local assessment or administrative purposes. The nation deliberately undertook this elaborate survey on the ground that no private enterprise could accomplish it satisfactorily; and now, after spending millions on its production, England hesitates to make use of it in the manner intended by the able statesmen and scientific men upon whose recommendation it was authorised by the Government of the day.

It is hardly necessary to refer to the errors, irregularities, and inconsistencies of the valuation for local assessment in this country, and to the erroneous areas in the rate books. The areas of some parishes in the Poor-law Return of 1882 are as much as from 400 to 1,600 acres less than the true areas ascertained by the survey. In one parish an owner is rated for 140 acres more than he possesses, and another owner for 84 acres less. The valuation list, directed by Section xiv. of 25 & 26 Vict. cap. 103, to be made by overseers of parishes, does not refer to the Ordnance Survey or its maps; and it may be said that, as a rule, the guardians, overseers, and rate collectors act as if there were no such maps in existence as those of the survey.

The boundary question is somewhat complicated by the powers which the County Councils now possess of making orders for the alteration of parish and ward boundaries, without any provision having been made for mapping and recording the changes for the use of Government Departments and the general public interested. It would seem very desirable that the arrangements in Great Britain, in regard to boundaries, should be

assimilated to those in Ireland; and also that the Ordnance Survey plans should be used for valuation for rating purposes.

The Ordnance Survey maps on smaller scales might also be used advantageously as the basis for the preparation of statistical maps.

The use of these impressions and photography enables us with ease to produce maps with special information upon any scale. If, for instance, it were necessary to produce a purely military map of the country, it would only be necessary to pen in, upon a blue impression of the 1-inch map, the details that were required, and then photograph it.

The price at which the Ordnance Survey maps are sold has been much criticised, and has been compared unfavourably with the prices of foreign maps. This question is a somewhat complicated one; and it is not easy to institute a fair comparison between the selling prices of English and foreign maps. For instance, in England the map agent receives 33½ per cent. for handing the maps over the counter; that is, for every 1-inch impression sold, the agent receives 4d. of the shilling paid by the public; for every 3s. 25-inch map he receives 1s. He receives also 33½ per cent. on the cost of colouring: thus, if a town plan costs 10s. to colour, 5s. has to be added to this for the agent. This, in itself, is a heavy tax on the English maps; and, it may be added, that the paper on which the English maps are printed is much superior to that used abroad. As regards the actual cost of production, I believe England can compare favourably with foreign countries.

Since the 1st January, 1885, the sale of Ordnance Survey maps has been entrusted to the Stationery Office. The Director-General of the Survey carries out the survey and manufacture of the maps, and there his functions and responsibilities cease. As regards the disposal of the maps, he supplies the Stationery Office with such maps as it requires for sale, all arrangements for sale resting with that department.

DISCUSSION.

General A. DE C. SCOTT said with regard to that branch of the survey work which had been alluded to as being due to himself, it was only fair to point out that all new processes were more or less built up by the efforts of numbers, and that was so in the present case. Photo-lithography and photo-zincography were in part due to men like Mr. Pouncey, who discovered the use of bichromates in connection with pigments; Nièpce, who had a process which em-

ployed bitumen; Asser, who used bichromated paper, which was rolled up and used some thing like a lithograph stone; and Appel, who showed that any print in fatty ink could be transferred to stone. His own particular process involved a change in the methods which had been employed, resulting in producing a transfer which could be applied to any metal surface, and be printed from zinc. That proved successful, and when he left the Survey the results were so far satisfactory. On looking round the room, however, he hardly recognised the process he had left, so much had been done to enlarge and improve it, and he could not sufficiently express his admiration of the success which had followed the efforts of those who succeeded him. He believed they were indebted to General Cooke for those very large photographs, and he remembered when it was considered doubtful whether a lens could be produced which would give such impressions without distortion, which of course would render the whole thing useless. Ultimately, however, with the aid of an eminent optician, Mr. Dallmeyer, a lens was produced which succeeded. Since then he had watched the operations of the Survey with great interest, and it was a great pleasure to him to see that Department under Sir Charles Wilson and others had advanced with such giant strides.

Mr. ALEXANDER PAYNE said he had largely employed the map of London on the scale of 88 feet to the inch, and could testify to its wonderful accuracy. The maps were on such a scale that a thin line represented about a foot, and yet he had found repeatedly that he could find the scale of a small building more accurately from one than by measuring it with a 2-foot rule. He had measured hundreds of buildings from the map, and never found an error; in fact, for certain purposes, he never thought of taking the measure in any other way. He was glad to hear that London was going to be re-surveyed, because the suburbs had been so greatly altered that there were square miles almost of buildings not represented at all. Most of the maps he had were some thirty-five years old, and it would be an immense boon to Londoners when the survey was brought up to date. He had also used the 1-inch scale maps very largely, chiefly for pleasure, in wandering about the country, and could also testify to their accuracy. No matter where he were dropped down, if he had these maps, he knew how to get about, how long it would take, and the character of the country he was going through. It was a great misfortune, however, that the maps published some years ago were not divided into sheets in the same way as those of the new survey, for if you had an old map, and wanted to extend the area, you found the sheets did not fit. The French maps were wonderfully cheap; some were published on about our 1-inch scale, which were sold for a franc, and a quarter sheet, which had more country in it than one

of our 1s. maps, could be bought for 25 centimes. They were also very good, but they would not compare with the English survey.

Sir H. TRUEMAN WOOD remarked that one of the important points raised in the paper was the way in which the ordnance maps were supplied to the public. It was a great shame that, in whatever part of the country you might be, you could hardly ever get an ordnance map, but were always told you could have one copied from it, which was nearly as good, or better, or something of that kind. He believed the reason was, that the whole thing was in the hands of one firm, very eminent no doubt, and he had nothing to say against them; but it ought not to be in the hands of any individual firm: the maps should be supplied direct to the public at cost price. The British Association had appointed a committee on the subject, and, he believed, intended to make a protest about it, which he hoped members of the Society would support. He could also bear testimony to the value of the scientific work done by the Ordnance Survey Department. Everyone interested in the progress of photography knew how much that science owed to the work done by that department. The photographic work was carried on on a scale which could be seen nowhere else in this country, at any rate. The enormous negative now shown was a most magnificent piece of photographic work, and the regular production of such negatives must involve great difficulties. Photo-lithography and zincography also owed a great deal to the Ordnance Department; photo-zincography was really invented and perfected there, and great credit was due to the various officials, from the time of Sir Henry James, down to the present, for the way in which they had adapted and improved the various processes placed at their disposal. He could not understand why the smaller maps were not produced by a photographic process, which would do in six or eight months what took as many years by the more ornamental but not more useful work of the engraver.

Capt. J. P. MACLEAR, R.N., said he had had a good deal to do with the construction of Admiralty charts, but not with either the engraving or selling of them, and with those charts they knew exactly for whom they were working, and what they wanted. This was very different from the Ordnance Survey, where the maps were first constructed for military purposes, and then were expected to be used by farmers and others. Sir Charles Wilson had said nearly all there was to be said on the subject, and he would refer to one question—why these maps were not popular. He did not mean that they were disliked, but that the world in general knew very little about them, and very rarely bought them. In the Isle of Wight he believed there was only one 25-inch map, and he believed the Chairman and himself were about the only possessors of 6-inch maps. Very few even of the 1-inch were in use, and, in fact, comparatively few people understood them or

could use them. When he had spoken to farmers about it, and recommended them to get maps, they looked at him with astonishment. He thought it would be a good thing if map reading were more taught in the schools. With regard to the publication, he thought there should be more local dépôts, and if the profit were divided amongst the local men they would probably be willing to take it up. Possibly the large per-centage allowed to the publisher was to cover the loss on unsaleable stock, but certainly something ought to be done to push the sale of the maps.

The CHAIRMAN said they were much indebted to Sir Charles Wilson for this paper, but he should have been glad if he had given a little information with regard to the difficulties connected with the actual survey work. He remembered going through the Survey Department some years ago with very great interest, and hearing some very remarkable facts, some of which he had never forgotten. From a line on Lough Foyle, in Ireland, the whole country was triangulated across the Irish Channel to a line on Salisbury Plain, some five or six miles long. The lines were actually measured by wooden or metal rods, six or seven at a time being used, and only one being moved, the actual join being most carefully observed by a magnifying glass; and he remembered being struck with the fact that the actual measured line did not vary from the triangulated line obtained by calculation by more than a few inches—a most marvellous example of scientific work. It was interesting to look back, and see how short-sighted our predecessors were in this matter. Now that we knew the value of these maps, and knew how they had been appreciated in Ireland 30 or 40 years ago, it seemed extraordinary that, so lately as 1857, and even 1863, there should have been a fight as to the scale on which the maps should be prepared, and that years should be wasted in discussing the matter, and many thousand pounds actually thrown away. Having used these maps now for many years, and known their value, it seemed astonishing that, having once determined on a standard scale—it did not matter very much what it was, though there were certain advantages in the one adopted—they should not be set to work and carried out as quickly as possible. He thought Sir C. Wilson had a little underrated the estimation in which these maps were held; and he was very glad to hear the practical testimony of Mr. Payne. He could only say, having been taught practical surveying in his early days, he had always taken a great interest in it; and he had learned, during the last 15 or 20 years, that so good were the 25-inch maps that, where they were available, persons who desired to sell or purchase land did not go to the expense of an independent survey. He agreed with Captain Maclear, that ordinary agriculturists did not understand the use of maps, but they were not the only ones in that condition; it was not all sailors

even who were good hands at a chart. The great thing to extend the practical utility of these maps was to make people better acquainted with them. There ought to be local agencies for selling them in every county town; there was no need to interfere with existing rights, and he had no doubt the firm referred to would be glad to promote the sale. But besides that, they should be put up in the public halls and in public rooms and in villages; the expense would not be great, and a little familiarity with the maps themselves would do more to make their value appreciated than any amount of book-teaching. He should like to ask what prospect there was of any advance in the geological survey? It always seemed to him a matter of great regret, both with reference to scientific knowledge and general information, that there should be such a very limited portion of the country of which there was any detailed geological map. One map had been referred to which seemed to be of great value—that of the catchment basins—especially bearing in mind the importance of the water supply. He might add, in connection with the geological map, that the question of what becomes of the rainfall in certain districts was not half sufficiently studied. In certain parts of England the whole rainfall seemed to disappear into the earth, and it would be most valuable to have some information as to the strata in those districts. There was one other matter of importance which had not been alluded to. The dream of all land reformers was speedy land transfer, and in his opinion, from any point of view, quite disregarding political considerations, it was a matter of the highest importance that there should be the means of rapid and easy transfer of land. He remembered his father saying in that room, when this subject was being debated, that the foundation of speedy land transfer was a good map. It would be utterly hopeless to ask persons to deal in small plots of land, or that there should be expeditious modes of transfer, unless there were a good map to appeal to. If those interested in land transfer would only consider the assistance afforded them in being able to go to the Ordnance Survey, it would be much more likely to be brought into prominence, because the idea prevailed that in many counties there was no map upon which a man's property could be delineated, so as to show authoritatively what its boundaries and actual position were.

Sir CHARLES WILSON said the Ordnance Survey Department had nothing to do with the Geological Survey beyond engraving the maps which the Geological Survey sent them, but they had been sending a good deal of work lately, and he held that the 6-inch Geological Survey was still in progress. He ought to have mentioned in the paper, that by the new rules of the Land Registry Office in London, all land must be registered by the Ordnance maps. In reply to Mr. Payne, he might say that the new 1-inch map was entirely different from the old one, and the sheet lines in the new series were also different, and con-

sequently there must be inconvenience where the new and old series joined. Some of the old series were very bad. In Devonshire a large part of the work was done by contract during the old French war, and was not at all up to the mark. The new map of Devonshire was being pressed forward, and he hoped that in about four years time the whole 1-inch map would be published in outline. The question of expediting the publication by means of photography had been thought over, but it was considered that engraving was so much superior, and the time was so near when the whole work could be published in that form, that it was not worth while to issue a few sheets in photozincography. The new map of London would not be an engraved map, or few present would live to see it completed; it was proposed to publish it by photo-zincography. This would be a great test of the process, because the portions already issued were so splendidly drawn and engraved. He had recently had a specimen sheet done, and the result was extremely good; the lines were quite as fine as the engraving. The map would be published as each sheet was drawn, and he hoped it would come out in a reasonable time. He had always been of opinion that the way to teach geography was for each Board School to have an Ordnance map on the 25-inch scale of the locality round the school, and to show the pupils on the ground what the conventional features on the map actually represented. He advocated that seventeen years ago, when President of the Geographical Section of the British Association at Belfast, and had done so ever since. Some years ago, when at the head of the Intelligence Department in London, he read a paper at the United Service Institution, urging that these maps should be utilised by volunteer officers, and had some specimen maps prepared, showing how the 25-inch might be utilised in placing pickets and sentries for the defence of villages and houses. The sale of the maps was a delicate question to deal with, as it did not rest with his department, but he thought there would be no difficulty in bringing the maps home to every part of the country by simply hanging up a 25-inch map in every country post-office, and one of the little coloured indexes. Any one going into a post-office might get a postal-order, put on it the number of the sheet he wanted, send it to Southampton, and receive the map next day. The amount now paid for agency would entirely cover the cost of postage both ways. There was no difficulty in the matter if once it was set about in the right way. He knew of several gentlemen who utilised the maps in the way the Chairman had mentioned. Two or three regularly used a 25-inch map for recording the cropping of their fields. The map of Scotland on the wall had been produced by photo-zincography from the large scale map. Its engraving would have taken a very long time, but the whole map had been produced a good deal under 12 months, giving all the details required. The Geological Department

had wanted a map on that scale for some time, in order to publish one with the general geology of the country.

The CHAIRMAN then proposed a vote of thanks to Sir Charles Wilson, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

FRENCH WINE AND CIDER PRODUCTION IN 1890.

The French *Bulletin de Statistique et de Legislation Comparée* states that the production of wine in France for the year 1890 amounted approximately to 27,416,000 hectolitres, or 603,000,000 gallons—a proportion of 330 gallons to each hectare of land (hectare = 2.47 acres) under vine cultivation. This shows an increase of 92,000,000 gallons over 1889, and a falling off of 50,000,000, when compared with the average production of the last ten years. In 1889, the hectolitre (22 gallons) of wine was valued at 30s., while in 1890 it was only worth a little over 28s. According to this, the total value of the yield in 1889 amounted to £35,240,000, and to £39,560,000 in 1890. The increase is observable in 45 departments. It is particularly marked in the Basses Alpes (137 per cent.), the Alpes Maritimes (100 per cent.), Aveyron (105 per cent.), Savoie (99 per cent.), Var (84 per cent.), Rhône (70 per cent.), Drôme (68 per cent.), Vienne (68 per cent.), Allier (66 per cent.), Loire Inférieure (66 per cent.), Isère (65 per cent.), Puy de Dôme (62 per cent.), Pyrénées Orientales (61 per cent.), Loire (57 per cent.), Haute Savoie (57 per cent.), Bouches du Rhone (51 per cent.), Gard (46 per cent.), La Vendée (46 per cent.), Ain (41 per cent.), Herault (36 per cent.), Aude (20 per cent.), and the Saône-et-Loire (20 per cent.). *Per contra*, a falling off was noticed in 31 departments, chiefly in the following:—Morbihan (70 per cent.), Vosges (60 per cent.), Haute Marne (45 per cent.), Corrèze (41 per cent.), Meurthe-et-Moselle (38 per cent.), Eure-et-Loire (38 per cent.), Meuse (36 per cent.), Aube (34 per cent.), Sarthe (32 per cent.), Gironde (25 per cent.), and Haute Saône (23 per cent.). Viteulturists appear to have employed, as compared with 1889, much larger quantities of low-class sugars to improve the quality of their products, or to increase the yield. The quantity of wine declared for sweetening, which amounted in the first ten months to 19,561,618 kilogrammes, exceeded, in the period ending October 31, 1890, 32,000,000 kilogrammes. It was necessary, as usual, to have recourse to large importations of

foreign wines. During the first eleven months of last year, the quantity purchased from abroad amounted to 219,000,000 gallons. Spanish wines figured in the list to the extent of 150,000,000 gallons; Italian, 396,000; Portuguese, 4,180,000; Algerian, 38,000,000; and Tunisian, 198,404 gallons. In Algeria, wine cultivation continues to make progress. The area under vines has increased by 3,699 hectares, in 1890, and the yield amounted to 62,568,000 gallons in that year, as compared with 55,264,000 gallons in 1889. As regards cider, the yield in France, in 1890, exceeded that of 1889 by 162,000,000 gallons; and only falls short of the average production of the last ten years by 24,000,000 gallons. In Brittany and Picardy the yield was generally greater than that of an average year; in Normandy it was not so good; and the same remark applies to Mayenne and La Sarthe.

Correspondence.

SGRAFFITO.

I am sorry to have been unable to be present at the meeting of the 10th February, when Mr. Heywood Sumner brought the subject of "Sgraffito," as a decorative process, before the Applied Art Section of the Society of Arts. The experiments done at South Kensington Museum—the earliest of which, by the way, were carried out in the years 1858-9—were frequently referred to, both by Mr. Sumner and by the gentlemen who took part in the discussion. May I say that, at the suggestion of my father, the late Sir Henry Cole, I prepared and read a paper on this subject of "Sgraffito" at the Royal Institute of British Architects, in 1873? The somewhat full information concerning the history of sgraffito, and opinions upon the modern practice of the art, given by experienced men like the late Mr. F. Pepys Cockerell, the late Mr. T. Gambier Parry, the late Sir Digby Wyatt, Mr. Charles Barry, and others, are printed in the Sessional Papers, 1872-3, No. 9, of the Royal Institute of British Architects. All this, however, seems to have been overlooked last Tuesday. For the sake of history, at least, I therefore communicate this note of some little movement eighteen years ago in connection with sgraffito. Mr. Stannus seems to have posed as a *doyen* at last Tuesday's meeting. But I have the pleasure of knowing he is not what one would call an old man. Mr. G. T. Robinson mentioned an experiment tried by himself in sgraffito thirty years ago, that is about 1861, when, as he candidly owned, he knew not much about it. However, Mr. Stannus appears to have stated that Mr. Robinson commenced sgraffito "even before Sir Henry Cole took it up; and to him [Mr. Robinson presumably] as much as to any one, was due the

credit of having been one of the revivers of this art in England." It would seem that Mr. Stannus had rather over-stated his view of what Mr. Robinson had done, for Sir Henry Cole caused experiments in sgraffito to be made in 1858-9; besides this, however, it is hardly likely that Mr. Robinson was practising the art in 1849, when Mr. Stannus must surely have been a "schoolboy, with his satchel and shining morning face," and when Alfred Stevens offered to do any amount of sgraffito for Sir Digby Wyatt, at £3 per yard superficial.

ALAN S. COLE.

February 14, 1891.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

FEBRUARY 25.—E. J. RAVENSTEIN, "Colonisation and its Limitations." Sir RAWSON RAWSON, K.C.M.G., will preside.

MARCH 4.—J. HARRISON CARTER, "Modern Flour Milling." Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, will preside.

MARCH 11.—H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D., "Electricity in relation to the Human Body." W. H. PREECE, F.R.S., will preside.

MARCH 18.—F. H. CHEESEWRIGHT, "Harbours, Natural and Artificial." Lord ALFRED CHURCHILL will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock:—

MARCH 17.—Sir EDWARD N. C. BRADDON, K.C.M.G., Agent-General of the Colony, "Recent Development of Tasmanian Industries."

APRIL 21.—Sir THOMAS WADE, G.C.M.G., K.C.B., "China."

Papers for which dates are not yet fixed:—

LEWIS ATKINSON, "The Diamond Fields of South Africa."

C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

WILLIAM WYLDE, C.M.G., "The Opening of Africa."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

FEBRUARY 26.—ROBERT GORDON, M.Inst.C.E., "The Economic Development of Siam." Sir CHARLES EDWARD BERNARD, K.C.S.I., will preside.

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 30.—COL. J. O. HASTED, R.E., "The Perrier Project." The Right Hon. SIR MONTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, F.S.A., "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

POPULAR AFTERNOON LECTURES.

Friday afternoons, at half-past 4 o'clock :—

Captain ABNEY, C.B., D.C.L., F.R.S., "The Science of Colour."

February 20, 27; March 6, 13.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

LECTURE II.—FEB. 23.—Transmitting Live Power—Fundamental Principles—The Dynamo and Electromotor—Regulating Appliances—The Line—Best section of Conductor—Cost of Plant and Working Expenses—Examples.

LECTURE III.—MARCH 2.—Limit of Distance to direct Current Transmission—Alternating Current Transmission—Synchronising Motors—Ferrari's Motors—Motors for Small Powers—Electric Machine Tools.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 23... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Gisbert Kapp, "The Electric Transmission of Power." (Lecture II.)

Lantern Society, 20, Hanover-square, W., 8 p.m. Exhibition of Lantern Slides.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. A. R. Agassiz, "From Hai-phong in Tong-King to Canton, overland."

Actuaries, Staple Inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m.

Prof. C. Stewart, "Hearing, illustrated by types."

TUESDAY, FEB. 24... Chemical Society (at the House of the Society of Arts), 2 p.m. Jubilee Meeting.

Royal Institution, Albemarle-street, W., 3 p.m.

Prof. Victor Horsley, "The Structure and Functions of the Nervous System." (Part I.) "The Spinal Cord and Ganglia."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Messrs. Lewellyn B. and

Claude W. Atkinson's paper, "Electric Mining-machinery." 2. Mr. John Thornhill Harrison, "The Subterranean Water in the Chalk Formation of the Upper Thames, and its Relation to the Supply of London."

Society of Architects, St. James's-hall, Piccadilly, W., 7½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Technical Meeting. "The Dark Room and its Fittings."

Anthropological, 3, Hanover-square, W. 8½ p.m.

1. Rev. Charles Harrison, "Religion and Family among the Haidas." 2. Prof. D. J. Cunningham and Prof. A. C. Haddon, "The Anthropometric Laboratory in Dublin." 3. Prof. D. J. Cunningham, "Exhibition of the Skull and some of the bones of the Irish Giant, Cornelius Magrath."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m.

Mr. C. Jones, "Scavenging, Disposal of Refuse Sewage."

WEDNESDAY, FEB. 25... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. E. J. Ravenstein, "Colonisation and its Limitations."

Geological, Burlington-house, W., 8 p.m.

Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

THURSDAY, FEB. 26... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Robert Gordon, "The Economic Development of Siam."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m.

The Hon. J. Roden Noel, "Mr. E. Barrett Browning."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Alfred Gilbert, "The Moral and Intellectual Influences of Music."

Royal Institution, Albemarle-street, W., 3 p.m.

Prof. C. Hubert Parry, "The Position of Lulli, Purcell, and Scarlatti in the History of the Opera." (Lecture III.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

FRIDAY, FEB. 27... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Popular Afternoon Lectures.) Captain Abney, "The Science of Colour." (Lecture III.)

United Service Inst., Whitehall-yard, S.W., 3 p.m.

Prof. Rupert Jones, "The Utility of an Elementary Knowledge of Geology to the Officers of the Army."

Royal Institution, Albemarle-street, W., 8 p.m.

Weekly Meeting, 9 p.m. Mr. Percy Fitzgerald, "The Art of Acting."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. Bertram Chatterton, "Disintegrators."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m.

Mr. Shirley Murphy, "Infectious Diseases and Methods of Disinfection."

Clinical, 20, Hanover-square, W., 8½ p.m.

Browning, University College, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m.

1. Prof. W. E. Ayrton and Mr. J. F. Taylor, "Proof of the Generality of Certain Formulæ published for a Special Case by Mr. Blakesley. Tests of a Transformer." 2. Mr. T. H. Blakesley, "Further Contributions to Dynamometry." 3. Mr. Swinburne, "Note on Electrostatic Wattmeters." 4. Prof. W. E. Ayrton and Dr. Sampner, "Interference with Alternating Currents."

SATURDAY, FEB. 28... Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "The Forces of Cohesion." (Lecture III.)

Journal of the Society of Arts.

No. 1,997. Vol. XXXIX.

FRIDAY, FEBRUARY 27, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the course by Mr. GIBBERT KAPP, on "The Electrical Transmission of Energy," was delivered on Monday last, the 23rd instant.

The lecture was devoted to the consideration of the method of transmitting live power, and to the construction of the dynamo and electro-motor to be employed.

The lectures will be printed in the *Journal* during the summer recess.

POPULAR AFTERNOON LECTURES.

The second of the course of lectures on "The Science of Colour" was delivered by CAPTAIN AWNEY, C.B., F.R.S., on Friday, the 20th instant.

The lecturer showed how any colour whatever could be matched by a mixture of two of the spectrum colours, together with a proportion of white light, illustrating the fact by the use of Maxwell's revolving colour discs. He also explained how light was absorbed by suspended particles in the air, and gave a practical illustration of this by showing how the more refrangible rays of the spectrum were absorbed when white light was passed through a gradually clouding medium, so that the beam became first orange, then red, and finally disappeared altogether. He showed the method he had devised for comparing the luminosity of the various spectrum colours, and gave illustrations of the manner of its application.

The third lecture will be given to-day (Friday), at 4 30 p.m.

EXAMINATIONS.

Secretaries of Examination Committees are reminded that to-morrow, Saturday, is the last day for sending in returns of the number of candidates at each centre, and that the 7th March is the last day up to which additional papers can be applied for. The Examinations themselves will be held on the 16th, 17th, 18th, and 19th March.

Proceedings of the Society.

TWELFTH ORDINARY MEETING.

Wednesday, February 25th, 1891; SIR RAWSON RAWSON, K.C.M.G., in the chair.

The following candidates were proposed for election as members of the Society:—

Clarke, Charles Goddard, Ingleside, Elm-grove, Peckham, S.E.

Coleman, Harry, 34, Golden-square, W.

Lipscombe, George, 41, Westbourne-terrace, W.

Worsley, A. H. 135, Ladbrooke-grove, W.

The following candidates were balloted for and duly elected members of the Society:—

Buckeridge, Walter, 13, Durham-terrace, Westbourne-park, W.

Codd, John, 16, Hill-road, St. John's-wood, N.W.

Crews, Arthur E., 41, Portman-square, W.

Green, George William, 42, Duke-street, S.W.

Hunter, George B., Wallsend-on-Tyne.

Newton, Ernest, 14, Hart-street, Bloomsbury-square, W.C.

Stead, John Edward, 5, Zetland-road, Middlesbrough.

Treize, J. M. G., Moreton-house, Redruth, Cornwall.

Williams, Montague Scott, J.P., Woolland-house, near Blandford, Dorset.

The paper read was—

COLONISATION, AND ITS LIMITATIONS.

By E. J. RAVENSTEIN.

The colonisation of the thinly peopled and inhabited countries of this earth is a result of migrations, voluntary or compulsory. Our imagination is struck most with the effects of those great migrations which, between the fourth and sixth centuries, carried the northern barbarians into the smiling provinces of the decaying Roman Empire, or with

that wonderful exodus of European peoples which, in the course of little over three centuries, has peopled a new world, and given birth to at least one nation, which in numbers rivals even now our old-established European states, and which promises, in a no very distant future, to exceed even the untold millions of the Celestial Empire. Mighty, too, has been that current of enforced migration which transferred millions of Africans to the plantations of the New World.

But, simultaneously with these phenomenal currents, there flowed, and still flow, other currents, which force themselves less upon our attention, but which, nevertheless, in their effects upon the dispersion and distribution of the populations, bring about momentous and far-reaching results.*

If we examine a little more closely into this subject, we shall find that the whole of the countries of the world may be grouped into two divisions; the one including countries, the natural growth of the population of which is greater than the actual growth; whilst in the other, the actual increase is in excess of an increase which would have resulted merely from natural growth, or an excess of births over deaths. In other words, the countries included in the first division increase their population more or less largely at the expense of the countries included in the second division. The latter I call "regions of dispersion," the former, "regions of absorption."

The whole of Western Europe, with the exception of France, constitutes a "region of dispersion." The loss of population by emigration into other countries is more considerable in the case of Norway, where it amounts to 0.65 per cent. in the course of the year, Germany (0.43 per cent.), Sweden (0.28 per cent.), Portugal (0.27 per cent.), and the United Kingdom (0.26 per cent.), and least in the case of the Netherlands and of Spain. Of course, thousands of the migrants who annually leave these countries find their way across the ocean to America, Australia, and South Africa, but other thousands are satisfied with settling in European States, and notably in Russia and the Balkan peninsula. France, with its low birth-rate, is largely indebted for her increase of population, slight as that is, to immigration from Belgium, Germany, and Italy. The actual increase (1882-86) thus amounted to 0.32 per cent., whilst independently of this inflow of foreign elements, it would have

amounted to only 0.21 per cent. It must not, however, be forgotten that France uses up several thousand lives annually in her vast colonial empire. The Balkan States, on the other hand, and Russia, although the natural growth of their populations is quite as great, if not greater than in most other parts of Europe, absorb a large number of emigrants, more especially from Germany and Central Europe generally, because their population is comparatively scanty, and there still exist within them natural resources which invite development. I estimate, for instance, that Russia, between the year 1861 and 1886, made a net gain of at least 990,000 souls consequent upon foreign immigration. More recent years, owing to the compulsory emigration of many Jews, and the oppressive restrictions imposed upon the exercise of religious freedom, may possibly exhibit a different result. But the effects of measures such as these are never more than temporary, and the barrier once removed, the currents of migration must flow with all the greater force. But whilst for years a steady current of migrants has been flowing into Russia from Western Europe, a current of ever-increasing strength has been flowing out of it towards the east and south-east, into Siberia and the provinces of the Caucasus. When the railways now building, or proposed, shall give easier access to these distant countries, this emigration is sure to assume still vaster proportions, and if incidentally it should direct the attentions of the Russians to the development of their vast colonial possessions, we in Western Europe may have some reason for being grateful. An "Emigration Law," published in the course of last year, is intended to organise migration into Siberia; and several of its provisions, as for instance that which determine that allotments cannot be alienated or mortgaged, seem to be deserving of imitation elsewhere.

The great region of dispersion of Asia is China, notwithstanding the fact that several of the old provinces of the empire are still very thinly peopled. The Chinese have invaded the whole of the peninsula of Indo-China, they have crossed the sea into the Malay archipelago, and forced their way into Asia, and have crossed the wide Pacific, in the hope of finding remunerative work in the United States, and in British North America. But even more remarkable has been their recent invasion of Manchuria and Mongolia. Manchuria, more especially, has grown into a populous province within the memory of living

* See my paper on "The Laws of Migration," *Journal of the Statistical Society*, 1887.

men. Even the borders of Siberia have been crossed by the Chinese, but they are no more welcome there than in the countries of the Anglo-Saxons; and measures in restraint of their settlement have been taken. This may appear harsh, but, it must be confessed, that there is much justification for it, for an indiscriminate blending of races has nowhere proved a blessing; and for two distinct races to live side by side, without one of them exercising a deteriorating influence upon the other, is next to impossible. One feature in connection with this Chinese migration is deserving of notice, namely, that it is directed to both temperate and tropical countries, and that, to all appearance, the Chinaman equally well adapts himself to either. But, then, China stretches through 25 degrees of latitude.

The second great region of dispersion in Asia is the Arabian peninsula. Arabia, indeed, like other desert or steppe countries, affording but limited resources to an increasing population, has each sent forth at various epochs swarms of conquerors, and those have played an important part in times gone by, in the peopling of Northern and Eastern Africa. As to British India, I am inclined to think that losses by emigration are balanced by gains derived from immigration. Mountain regions and steppe plateaux, such as those which environ India on the landward side, have at all times sent forth their surplus population into the more favoured lowland plains which lie at their foot.

But whilst India occupies a doubtful position, there can be no doubt at all as to the fact that further India, Japan, and the greater part of the Malay archipelago, are regions of absorption. In the case of Japan, this is proved by statistical returns, which show that, in the course of four years (1884-88), the net gain from emigration amounted to 910,000 souls, while, in the case of the other countries mentioned, it is shown to be the case by the mixed character of their populations.

Africa, or, at all events that part of it which is the home of the negro, constituted at one time a huge region of dispersion. Happily, the exportation of slaves, which gave Africa that position, has now been stopped, or nearly so, and the Dark Continent has actually become a region of absorption, increasing its population partly at the expense of surrounding countries, including even Europe. Migratory movements throughout that continent appear to be going on on a huge scale. I need only remind you of the migration of various

tribes of Zulu and Bechuana to the northward, and of the manner in which certain inland tribes have pushed their way towards the coast. A movement in a contrary direction—that is, from the coast towards the interior—can likewise be noticed, more especially in Southern Africa, where the Dutch and British colonists have pushed northward, even into the tropical region.

America, taken as a whole, constitutes one vast region of absorption; but even now, although the population of no part of it can be called dense, as compared with that of Europe, “regions of dispersion” are becoming more and more prominent. There can be no doubt, for instance, that the great west is being fed at the present time at the expense of the eastern maritime provinces and states, although these themselves are by no means “settled up” to anything corresponding to their natural capacity. I do not doubt, however, that some fifty years hence, if not sooner, a contrary current will set in from the westward, and result in the older states—the natural resources of which are much more varied than are those of the west—increasing largely in population. Even some of the West India Islands have become centres of dispersion, and notably among them Barbadoes, which annually sends forth a large number of emigrants.

As to Australia, it is most distinctly a region of absorption.

Summarising these results, we may state that the great “regions of dispersion” at the present time are Western Europe, with the exception of France, and China; whilst the regions still capable of absorbing the surplus population of these countries are America, Australia, Siberia, and the tropical regions generally.

Having thus presented you with a general survey of the migratory movements going on throughout the world, I proceed to consider the extent to which they can be carried on, until the whole of this earth of ours shall be fully peopled.

The most obvious of the limitations is the lack of cultivatable land. It is clearly not necessary that the consumer of the products of the soil should himself live upon the land which yield them. The only question, therefore, which we have to answer is this:—Supposing all cultivatable parts of the world to have been brought into cultivation, what would be the number of people whom they would be able to support. Once that number is reached, colonisation would be at an end,

and no further increase of the population would be possible, without leading to a desperate struggle for existence. In order to arrive at an estimate of this kind, I have divided the whole of the earth's surface into three regions, viz, fertile regions, the regions of steppe-lands, and the deserts. What I call the fertile region is, however, not wholly capable of remunerative cultivation, for within it lie mountain districts which will never tempt the agriculturist—sandy tracts, capable of supporting only forests, and even steppes or savannahs, not fit for anything except the raising of cattle. Take, for instance, Europe, with the exception of Russia and Turkey, where nearly all the land capable of being cultivated has been occupied, you will find that not quite 40 per cent. of the total area is under the plough, 18 per cent. is described as meadows or pasture lands, and 23 per cent. is covered with forests. The remainder (20 per cent.) is covered with water, built upon, or consists of barren wastes. I estimate that these fertile regions cover an area of 28,269,200 square miles; and out of this, applying the proportions found to exist in Europe, about 7,237 million acres would be capable of cultivation, apart from what would be yielded by pasture-lands and forests. Passing over to the "steppes," or poorer grass-lands (13,901,000 square miles), it must be borne in mind that within them there exist large areas which can be rendered highly productive, especially where means for irrigating the land are available. The deserts cover 4,180,000 square miles, whilst the Polar regions, beyond the limits within which cereals can be cultivated, extend over 4,888,800 square miles.

The present population of the world I estimate to amount to 1,467,600,000 souls; and I believe that, once this earth of ours is fully brought under cultivation, it would be capable of supplying food and the other necessities of life to nearly 6,000 millions.

The stages by which I have arrived at these estimates have been fully explained by me at a recent meeting of the British Association*, and I need, therefore, only say that I have assumed that our standard of life should remain pretty much the same as we find it to exist in various countries and climates at the present time, and that the land should be rationally cultivated. Even in many parts of Europe our methods of cultivation are capable of much improvement,

whilst in all newly-settled country, where large tracts of unoccupied virgin soil are still available, agriculture is carried on in the most wasteful style, the cultivator looking only to immediate returns, without ever thinking of the prosperity of his descendants.

In the United States, for instance, thousands and millions of acres have gone out of cultivation, and the forests have been devastated in the most reckless style. These things, however, will right themselves in the end; the exhausted soil in the eastern and southern States will recover; the forest ^s so wantonly destroyed, will be re-planted, and in proportion as population increases so will the resources of each country be more carefully husbanded.

We are told sometimes that even now nearly all the available land in the United States has been disposed of, and that agriculturists have been tempted into regions where agriculture no longer yields a return to be depended on. There is some truth in this. Of the millions of acres still not yet alienated, the bulk consists of poor grass land, mountain regions, and even absolute deserts, which could never be made to yield crops; but of the 426 millions actually alienated, only 180 millions of acres are cultivated; and it only needs an examination of the agricultural returns to make it clear to us that these cultivated lands, if cultivated on scientific principles, might be made to yield nearly double what they yield at the present time. In Australia, although 116 million acres have been alienated, not quite 12 million acres are under cultivation.

The second limitation to colonisation is presented by the climate. This is a question more especially interesting to us Europeans, for if it should be found that Europeans were capable of becoming acclimatised in tropical regions (19,500,000 square miles), there would be available for our colonists vast tracts in Africa and South America, which are at present very thinly peopled, but which are undoubtedly capable of supporting millions of human beings with food and raiment. I am quite willing to concede that Europeans can live in tropical regions for a number of years without returning to their native country to recruit their health, but this is not "acclimatisation." In no single instance has it been proved that acclimatisation has proved a success, either in India, or in Java, or even in tropical Brazil. The Europeans in these countries would die out if they did not continually receive accessions from their countrymen in Europe. Stop these supplies,

* See my paper in Proceedings, Royal Geographical Society, January, 1891.

and the explorer of some future period might find no more traces of European blood in those countries than does the traveller in Spain or Northern Africa, who looks for the descendants of Goths or Vandals.

There is no doubt the sanitary measures have largely tended to lower the death-rates among European residents, and this is important if the tropical countries are to be governed by Europeans, and native labour is to be directed to them. That mortality, however, is still very high. In proof of the comparative healthiness of the climate of the Congo State, it has been asserted that the death-rate among European officials only amounts to 60 in the 1,000. But that is a tremendous mortality, especially if it is borne in mind that it occurred among picked men in the prime of life, not one of whom had been sent out to Africa without a medical certificate of fitness, and many of whom returned, invalided, long before the expiration of their three years' service.

We are told, sometimes, that by ascending a plateau within the tropics, the European can secure any climate he may find suitable. Nothing could be more fallacious. Elevation modifies, but does not change the characteristics of a tropical climate. The difference between the coldest and warmest month of the year is still very small, and would be smaller still if it were not for the great diurnal range—that is, the great difference which exists between the temperatures of night and day, a difference which may prove refreshing for a time, but which ultimately exercises a most baneful influence upon European constitutions.

Compare the climate of Kakoma, on the Unyamwezi plateau, at an elevation of 3,600 feet above the sea, with that of London. At Kakoma, the mean temperature of the year is 72°, the annual range amounts to 16°, and the diurnal to 29°, whilst the relative humidity does not exceed 62 per cent. In London, the relative humidity rises to 80 per cent., but the mean temperature does not exceed 50 per cent., whilst the annual and diurnal ranges amount to 26° and 11° respectively. There could exist no greater contrasts between two climates. Of course, you may ascend still higher, and attain an altitude insuring what has been called a perpetual spring. But, even then, quite irrespective of the fact that plateaux of such an elevation, and, at the same time, deserving the attention of settlers, occupy but small areas, this "spring," is not the spring experienced in temperate regions.

Under these circumstances, it appears to me that tropical countries can never become the permanent home of nations of European origin, unless, indeed, experience should prove that an advance from the temperate regions could be effected by stages, each change marking a generation of man. At the same time we must not lose sight of the fact that there is a distinction between mathematical and physical climates, and that geographical features may favour a European advance beyond the line marked "tropic" upon our maps. Such an exception, I thought, might exist in the case of the Matabele plateau, which stretches like a broad pier into tropical Africa, and enjoys an exceptionally favourable climate. Similar conditions appear to exist in southern Brazil. I need hardly say that, when I made a similar remark at Leeds, I did not do so in order to favour the projects of the South Africa or of any other colonisation company, as suggested by a German colonial paper, but simply in the interests of truth. Indeed, schemes of colonisation dependent for their success upon the possession of tropical countries, will derive but little comfort from anything I said before, or may have said to-day.

But if the tropical regions hold out but small prospects to European colonists, they appear to be suited to Chinese, and would certainly suit the natives of British India.

If what I have said is in agreement with facts, European colonists, cultivating their own land, can never hope to establish themselves within the tropical regions. But notwithstanding this limitation, the tropical countries may in future contribute much more largely to the sustenance of the human race than they have done hitherto. And this development, I need hardly say, is one of paramount importance; for unless it is brought about, the great food question must arise at a much earlier date than would be the case otherwise.

A third limitation to colonisation would arise from a failure in available colonists. Even now there exists a country in Europe—to wit, France—which would be quite incapable of undertaking the settlement of one of the larger English colonies, unless, indeed, the birth-rate, in response for a call for more men, were to rise very considerably. Nor are there wanting signs elsewhere which seem to indicate that the birth-rate in our older States is falling, or that the superior race increases at a slower rate than do the inferior races inhabiting the same country. Are we to look upon these differences as the result of some

physical law, the continued operation of which would, without violence, war, or pestilence, prevent the over-population of the world, or are they the result of moral restraint or physical checks, voluntarily submitted to? However this may be, for the present, at all events, there is no lack of willing colonists. The world's population may be supposed to increase at the rate of 8 per cent. in every decade. By the close of this century, the 1,468 millions, who now dwell upon the earth, will have increased to 1,587 millions, whilst 182 years hence, supposing the present increase to continue, there would be 6,000 millions, and the whole of the cultivable area of the globe would have been placed under contribution to support this multitude. The occupation of the coloniser would have gone; his aims and conquests would have to be studied from books of history, and a question which now occupies the minds of practical men, would form the subject matter of discussion at the meetings of historians and archaeologists. But long before this time arrives, our legislators will no doubt have devised measures for checking the increase of the population, and maintaining a reasonable proportion between the available food supplies, and the number of mouths to be fed.

DISCUSSION.

The CHAIRMAN said he had hoped Mr. Ravenstein would have entered more into the question of colonisation, which, at the present time, was one of great interest and growing importance; but he had really confined himself to the question which he propounded at Leeds, of the extent of available land on the earth's surface, and the time at which it was likely to be filled up if the population continued to grow at its present rate. His own impression was that the several factors affecting the question would change in a variety of ways which could hardly be anticipated. He believed that God, who placed man on the earth, intended that, by the growth of the several races, they should spread over the face of the earth; and he felt equally confident that the same Providence would provide for that population as it grew, all that was required for it; and he trusted would also guide the Governments and the people to avail themselves of the means which were placed within their reach; so as to prevent the inconveniences which were now growing upon us, the results of much ignorance, much neglect, and much wrong direction of social forces. Therefore, though it was interesting to speculate whether the population of the world, which was now about 1,500 or 1,600

millions, would in 200 years reach 6,000 millions, he did not think it was a very practical question at present. He hoped, if he had time, Mr. Ravenstein would follow up in more detail his calculations as to the area of land in different climates which were available for emigration from temperate countries, and even warmer ones, such as Southern Europe and China. He was surprised to find that the average population per square mile in China was considerably below that of Germany. The ability of the Chinese to stand hot and cold climates had been accounted for by the fact that they were drawn from different parts of the country, chiefly of the coast, which were in very different latitudes. He believed there were parts of China now almost unpopulated, though quite fit for population; but the Chinese had no means, or very imperfect ones, of inland transport, except the rivers. The population of China was about 90 to a square mile; whilst that of France was 60; Germany, about 112; Italy, 260; Switzerland, about 170; and Belgium, upwards of 500. If Belgium could provide for its population, and thrive as it did with such a dense population, surely there were ample means throughout Europe of providing for the population, if they were content with their social position. Germany was a dispersing country, however. In the United States there were a much larger number of Germans, or children of Germans, than either English or Irish, the numbers being:—Germans, 4,500,000; Irish, 4,200,000; English, 2,000,000; Scotch, 300,000; Scandinavians, 900,000; British North Americans, 1,200,000; and all the rest of the world, 1,300,000. If Belgium could support 500 to a square mile, surely Germany, if its social condition were such as to encourage population to remain, could support more than 112. And, similarly the other nations of Europe would be able to support a much larger number if they availed themselves of the means at their disposal, and used those influences which governments were constituted to exercise. Colonisation would then be less necessary, and the period when the world would become full would be delayed. There was this difficulty with regard to colonisation, that those countries which had profited by it in the past now said they did not want it. They did not mind a few picked men, but they did not wish merely to increase their numbers, or to be inundated with unskilled labour which would reduce wages. That was very much what was now going on in Australia and in the United States. They did not want a pauper population; their own people wanted to turn their resources to better account, but they did not want more foreigners. It was not unreasonable for a civilised nation to say that they did not want an accession of inferior classes, and that the country was injured by the introduction of a large number of less educated and less civilised people, who were less able to promote the wealth and prosperity of the country. As each country acquired—at first, through the accession of foreign labour—the

means of growth and establishing production and commerce for itself, the less would they desire an increase of population from abroad. All these forces would affect the question of colonization, and therefore the problem was not quite so simple as it might at first sight appear; nor did he think they need trouble about what would happen at the end of half the period which Mr. Ravenstein had provided for the filling up of the world. However, they were much indebted to him for a very interesting paper, and he begged to propose a hearty vote of thanks to him for it.

Mr. R. MANUEL asked if it was not the fact that Belgium was largely an industrial and manufacturing country, and imported a great portion of the food it required in exchange for its manufactures. If so, that would account for its being able to support such a dense population. As he understood the argument of Mr. Ravenstein, it was that when the countries which now took these manufactures ceased to do so, on becoming more advanced themselves, there would be a danger of Belgium and such countries finding a difficulty in obtaining the requisite food.

The CHAIRMAN said it was quite true that Belgium depended, to a great extent, on imported food; but at the same time, owing to the prevalence of spade husbandry, she produced more food comparatively than most other countries. Germany was also a manufacturing and mining country, and he saw no reason why she should not bear as dense a population as Belgium.

Mr. W. G. TREWBY remarked that, within the last few years, large districts in California, which previously had been unproductive, by means of irrigation had been rendered fertile, and now grew large crops of fruit; and the same thing was going on in Australia. It was anticipated even that the deserts of Africa, if properly irrigated, might be cultivated. There were also great differences in the degree of cultivation; English corn lands would produce 40 bushels per acre, while the average in America was 12 bushels; so that the crop could be increased threefold if necessary.

The CHAIRMAN said the same point had occurred to him. Many lands, now desert, once supported a large population.

The vote of thanks having been passed unanimously,

Mr. RAVENSTEIN, in reply, pointed out that he had already dealt with the points raised by Mr. Trewby; and stated that the 180,000,000 acres of land now under cultivation in America might be made to yield double the produce they now did. He doubted if it could be trebled. With regard to the

chairman's remarks about Belgium, and other countries on the Continent supporting themselves, he could not quite agree with him. In Europe, they lived, for the most part, on produce sent from other countries. Germany was no longer self-supporting, nor was France; and Belgium was very largely dependent on foreigners for the bread she ate. No doubt, even in Europe, the methods of cultivation might be improved, but there was a limit to improvements of all kinds, and agricultural improvements did not always make such rapid progress as they would like. He calculated that the whole of Central Europe, including Austria and the Balkan peninsula, if they clubbed together, and agriculture were slightly improved, might be self-supporting, because some of them were now exporters of food. If they could get the people in tropical countries to cultivate the land to its full capacity, and send us food in exchange for our products, it would not be necessary for the consumer to live on the land he cultivated. Even now, in most instances, this was the case; but if our population went on increasing without our food products increasing accordingly, we should be more and more dependent on food from abroad. That was why he insisted on tropical countries being made to yield as much food as possible, otherwise the time would come, in less than 180 years, when food supplies might fail, and with them all hope of progress of any kind.

Miscellaneous.

PETROLEUM WEALTH OF RUSSIA.

M. B. Prilëjaïev, writing in the *Economiste Russe*, says that the development which from year to year is seen in the production of mineral oil in Russia, the increased exports abroad and the competition on foreign markets with American products, and, finally, the fears that have recently been expressed as to the probability of an approaching exhaustion of the sources of petroleum in the Caucasus, invest with a particular interest this important branch of Russian industry. The following is a summary of the progress effected, and the present condition of the petroleum trade. The extraction of naphtha is confined almost exclusively to the Caucasus, in the peninsula of Apchëron, and principally in the environs of Baku. The existence of petroleum in the Caucasian soil was known at a very early period, and when these districts were still under Persian rule, the Government made concessions to private individuals of the right of working the petroleum beds. After the annexation of Baku to Russia this industry was at first a monopoly, which brought into the treasury, from 1821 to 1872, an annual revenue of 87,000 roubles.

After the suppression of this monopoly in 1872 an excise duty was imposed which was removed in 1877, and had yielded a total sum of 1,218,739 roubles. The yield from this source to the Imperial Exchequer in 1888 was nearly 7,000,000 roubles, and in 1889 over 9,000,000. From 1832 to 1862 the production of naphtha in the Caucasus was confined within narrow limits. During this period it varied from 255,500 pounds to 358,300 pounds annually (the pound is equivalent to 36 lbs. *avoirdupois*). From 1863 to 1868 it rose to between 538,900 and 998,900 pounds, and continued to rise until it amounted to 1,685,229 pounds in 1869, the year from which its enormous development dates. In 1870, the production amounted to 1,704,465 pounds; in 1875, to 6,285,728; in 1880, to 20,736,949; in 1885, to 115,000,000; and, in 1889, to 206,897,100 pounds. The environs of Baku supplied about 99 per cent. of the Caucasian production; in round numbers they yielded 165,000,000 pounds in 1887; 190,000,000 pounds in 1888; and 205,000,000 in 1889. The producing districts are situated at a certain distance from the town, on the plateaux of Balakhani, Sabountchi, and Sourakhani towards the north-east, and in the Bibi-Eibat fields which are to the south-east of Baku. In the Baku basin there were 216 wells in working in 1887, and 239 in 1888. The quantity of naphtha carried from the wells to the distilleries amounted to 186,220,470 pounds in 1889, and from January 1st to August 1st of 1890, it amounted to 138,782,688 pounds (against 99,930,712 pounds for the corresponding period of the preceding year). Professor Mendéliev estimates the daily production of the Baku district as follows:—In 1886, 328,890 pounds; in 1887, 415,000 pounds; and in 1888, 503,120 pounds. The Balakhani and Sabountchi fields are the most important. In the former there were 216 wells, in 1885, and in the latter 128. In 1887, the number of wells in both districts in full working amounted to 201, with a product of 153,246,672 pounds; and in 1888, they amounted to 227, giving a yield of 176,332,226 pounds. The average annual yield for each well was 762,421 pounds in 1887, and 776,794 pounds in 1888, an increase for the latter year of 2 per cent. The principal companies engaged in the extraction of petroleum are the Nobel, Caspian, Baku, Caspian and Black Sea, Schibaïev Mirzoev, Dembo and Cohan, and Zaturov and Arafelov Companies at Balakhani, Sabountchi, Tagueiev, and Sarkissov, and the Djakeli Companies at Bibi-Eibat. The petroleum extracted from the wells is carried by pipes to the large stations or reservoirs, and thence distributed in the same manner to the works. This system was inaugurated in 1877. The quantity of raw petroleum delivered to the works by the Baku Companies amounted to 153,122,049 pounds in 1888, 186,220,476 pounds in 1889; and 192,044,202 pounds during the period comprised between the 1st January and the 1st November, 1890. The distilleries are, for the most part, established at Baku, where they form a special district, which is known as the "black town."

In this district there were 145 distilleries in 1887, which treated nearly 142,000,000 pounds of naphtha, and produced 38,000,000 pounds of refined petroleum (kerosene), 1,800,000 pounds of lubricating oil, and 40,000,000 pounds of residues, besides a considerable quantity of benzine, vaseline, and products of secondary importance. In 1889, the number of distilleries was 147, and their total product amounted to 181,590,232 pounds, of which 62,000,000 were light oils, 1,000,000 heavy oils, and 113,000,000 residues. Independently of the Baku basin, naphtha wells are found in other regions of the empire. In the environs of Tiflis naphtha is found in the neighbourhood of Signakh, and at Naftlough. In 1887, there were 85 wells, which yielded 28,660 pounds of naphtha. In 1889, the Signakh wells alone furnished 55,296 pounds; that is, more than 17,000 pounds than the preceding year. In the Government of Elisasetpol, the production was only 2,000 pounds in 1888, and 3,000 pounds in 1889; in Daghestan, it was 3,350 pounds in 1888, and 3,955 in 1889; in the province of Térek, 161,442 pounds in 1888, and 275,721 pounds in 1889. The wells of the province of Kouban are of greater importance. The following will show the distribution by districts of the petroleum refineries and their relative production in 1889:—Transcaucasia, 148 refineries, with a production of 158,259,869 pounds; St. Petersburg and Moscow, 35, and 1,515,559 pounds; Central regions, 8, and 1,480,208 pounds; Southern, 6, and 944,689 pounds; Western, 2, and 324,215 pounds; Baltic provinces, 1, and 317,427 pounds; Northern, 1, and 15,719 pounds; South-Western, 1, and 1,799 pounds; and Poland, 1, with a product of 511 pounds; making, in the aggregate, 203 refineries, with a yield of 162,859,996 pounds. The working of petroleum at Baku is placed under the direction of a committee of experts, established in 1886. The greater part of the petroleum extracted is consumed in the interior of the empire. The petroleum is carried from Baku by the Caspian Sea, then by the Volga to Tsaritsyne. From this place, a certain quantity goes up the river, but the greater part is carried by rail, in tank-wagons, to all parts of European Russia. The Nobel Company owns the largest amount of material for the transport of petroleum; in 1889 their vessels represented a value of nearly 6,000,000 of roubles, and their tank-wagons 3,000,000; the wagons belonging to the Caspian and Black Sea Company represented a value of 448,773 roubles. The Naphtha Company owns 2,310 tank-wagons; the Schibaïev, 305, and the Caspian Company, 200. These companies also own reservoirs in the principal cities of the empire. Petroleum intended for foreign markets is shipped chiefly from the port of Batoum. The exports keep pace with the development of the petroleum industry. The importance of lighting oils in this export is accentuated from year to year. In 1883, refined petroleum only represented 41 per cent. of the total exports; the following years the proportion amounted respectively to 57 per cent., 67 per cent., 61 per cent., 62 per cent.,

78 per cent. to attain the figure of 84 per cent. in 1890. In the year 1889, over 6,000,000 pounds of lighting oils and benzine were exported from Russia to the United Kingdom; 4,000,000 to Austria; 3,000,000 to Germany; 2,000,000 to Italy; 2,000,000 to Belgium; and smaller quantities to Holland, Roumania, Spain, Denmark, Sweden, Norway, Greece, France, &c. Turkey took in the same year 7,000,000 pounds; East Indies, 5,000,000; China, over 1,000,000; Persia, 336,000; and Japan 330,000 pounds of lighting oils and benzine. In 1888, 77 per cent. of the total exports were effected *via* Batoum, and in 1889, 80 per cent. M. Priléjaïev concludes by quoting the opinion of Professor Mendéliév to the effect that there is no indication of an approaching failure of the petroleum supply of the Baku basin, leaving out of the question the other districts of Russia which still await the development of their naphtha wealth.

HORSE BREEDING IN NEW SOUTH WALES.

Mr. Coghlan, New South Wales Government Statistician, in his report on the wealth and progress of that colony, says that New South Wales is eminently fitted for the breeding of most descriptions of horses, and attention has long been directed to this industry. At an early period of its history the colony was enriched by the importation of some excellent thoroughbred Arabians from India; and the high name which was acquired by the horses of Australia was largely due to this cause. The abundance of good pasture everywhere obtainable also contributed to this result. The native kangaroo grass, especially when in seed, is full of saccharine matter, and young stock thrive exceedingly upon it. This abundance of natural provender allowed a large increase in the stock of the settlers, which would have been a great advantage, had it not been that the general cheapness of horses led to a neglect of the rules of breeding. In consequence of the discovery of gold, horses became very high priced. Under ordinary conditions this circumstance would have been unfavourable to the breed of horses, and such was the case in Victoria; in New South Wales it was far otherwise. The best of the stock of that colony, including a large proportion of the most valuable breeding mares, was taken by Victoria, with the result that, for twenty years after the gold rush, the horses of the colony greatly deteriorated. One class of stock only escaped. The thoroughbred racer was probably improved both by the importation of fresh stock from England, and by the judicious selection of mares. The period of deterioration ended about the year 1870, since which year there has been a perceptible improvement in all classes of horses. As regards the actual number of

horses in the colony, this shows but little increase for the last sixteen years, the figures for 1874 being 346,691; 1880, 395,984; 1885, 344,697; and in 1889 there were 430,777. The annual increase in the number of horses has not been more than 1·45 per cent. during the whole period covered by these sixteen years, while the increase of population has been at the rate of 4·56 per cent. For purposes of classification, the horses of the colony have been divided into draught, light harness, and saddle horses, the number of each particular kind being as follows:—Draught horses, 139,378; light harness, 109,659; and saddle horses, 181,740. New South Wales is, says the Government Statistician, specially adapted for the breeding of saddle and light harness horses, and it is doubtful whether these particular breeds of Australian horses are anywhere surpassed. The bush horse is hardy and swift, and capable of making very long and rapid journeys, when fed only on the ordinary herbage of the country; and in times of drought, when the grass and water have become scanty, these animals often perform astonishing feats of endurance. Generally speaking, the breed of horses is improving, owing to the introduction of superior stud horses and the breeding from good mares. When there has been a deterioration in the stock, this has been due, it is stated, to breeding from weedy mares for racing purposes, and from the effect of the drought. The principal foreign markets for horses are the Indian and Chinese. The total number of horses leaving the colony for markets outside Australia during 1889 was only 668. Although the demand for horses in India is considerable, and Australia is a natural market from which supplies may be derived, there is no one, according to Mr. Coghlan, employed by the Indian Government to make himself acquainted with the resources of the various colonies, or to furnish information to intending shippers. The speculation of sending horses to India is one open to many risks, as, apart from the dangers of the voyage, there is always an uncertainty as to the stock being accepted. It is stated that the number of horses in the Australian colonies in the year 1889 was as follows:—New South Wales, 430,777; Victoria, 329,335; Queensland, 352,364; South Australia, 170,515; Western Australia, 42,816; Tasmania, 29,778; and New Zealand, 187,382; making a total for Australia of 1,542,957.

CERAMICS IN DENMARK.

Her Majesty's Consul at Copenhagen, in his last report says that among Danish industries worthy of special mention is the Royal Porcelain Manufactory. Originally started in 1775 by a private firm, it was shortly after taken over by the State, for whose account it was carried on up to 1867, when it again passed into private hands. In 1882 it was purchased

by the Alumina Company of Copenhagen, and the two establishments have since been carried on side by side. Ever since its foundation the Royal manufactory has confined itself to the production of hard porcelain, the principal components of which are kaolin quartz and feldspar. The aim of the managers has always been to produce wares of a high technical and artistic value. To accomplish this, the State made considerable sacrifices, so much so, that during the whole of the period up to 1867 there was an annual deficit to be made good. Under private ownership, while artistic traditions have not been departed from, production has increased, and new outlets have been created, so that of late years economical results have been more satisfactory. Many of the first artists of Denmark have worked for this establishment. Hitherto the principal productions had been statuettes and bas-reliefs in unglazed white porcelain, mostly reproductions of Thorvaldsen's works; the well-known Danish-blue table services; Dresden services, with delicately-executed conventional bouquets, and the *Flora Danica* services, originally produced as a gala service for the Royal table. In this service each piece is painted in over-glaze, with a single flower or plant indigenous to the country. The subjects are treated realistically, without any attempt at conventional arrangement, and the effects produced is very striking. Under recent management, however, a number of accomplished artists have been engaged, and many new designs have been produced. Their efforts have been chiefly directed to under-glaze painting, and a very rare degree of perfection has been attained in this branch of the art. Their aim has been, at the same time, to give their productions a distinctly Danish character, by a close study of Danish fauna and scenery. In the process here referred to, the most delicate vases are fired at the high temperature of 2,000° centigrade. Vases and platters decorated in this style realise high prices, ranging from £30 to £80 a piece; the subjects depicted are original paintings, and are never reproduced. Among examples, remarked during a recent visit, Consul Inglis says there was a platter representing a flock of gulls circling over the crest of a wave, the dazzling whiteness of the breast plumage being rendered with remarkable truth by the untouched ground of the porcelain, softened down with a peculiar opaline glaze. Other subjects, represented with equal success, were a flight of wild swans across a misty landscape, and fish disporting themselves amid gracefully waving fronds of aquatic plants, the arrangements showing, perhaps, Japanese inspiration. In another platter, with white lilies against a misty moonlight landscape with water, a beautiful effect was produced. This choice example was to be sent to Paris, and was priced £80. Some vases, with admirably depicted white mice on a deep olive ground, were also most worthy of notice. The mark of the Royal Danish Porcelain Manufactory is characteristic, and has remained unchanged since its foundation. It consists of three wavy lines, repre-

senting the Sound, and Great and Little Belts. The collection of ceramic ware displayed by this establishment at the last exhibition at Paris came as a revelation to the French artistic world, and received the highest award. Since then an agency has been opened in the French capital, and it is hoped shortly to do the same in other European capitals, so that, Consul Inglis adds, dwellers in London will no doubt have an opportunity before long of judging for themselves of the beauty and originality of these high-class productions.

OLIVE CULTIVATION IN NORTHERN PERSIA.

The district in northern Persia where olives flourish naturally consists of forty-three villages, which are situated on the confines of the province of Gilân, between Rustemabâd on the north, Manfeel on the south, Taum on the west, and Rahmetabâd on the east. Her Majesty's Secretary of Legation at Teheran says that this group of villages possesses from 80,000 to 100,000 trees, which yield on an average from six to nine pounds of olives per tree per annum, thus giving an annual produce of 560,000 pounds of olives, if the former average be taken. The quantity of good olive oil derived from the Persian presses may be estimated at 17 per cent. of the olives, which would give 127,000 pounds of good oil. The good oil having been extracted, the residue is again pressed, and an oil of inferior quality is produced, which is used in the manufacture of soap. The value of the oil after a good harvest is two *krans* (about 1s. 2d.) per bottle of two pounds weight, at Resht or Teheran, whereas the maximum price paid per bottle after a bad harvest is five *krans*. In obtaining the oil the following process is employed. The olives are gathered late in the autumn, and at once stored in a kind of large bin, where they are left to ferment till the first spring suns, that is to say, till about the festival of the Persian new year, March 21. The olives are then spread out to dry on the flat house tops. When perfectly dried, they are again packed till they ferment. After this second fermentation, they are trodden by men, somewhat after the fashion in which grapes are trodden in the wine press. After having been thus trodden they are boiled, and after boiling crushed in a sort of press between flat stones, a receptacle for the oil being placed beneath the stones. A monopoly for the working and purchase of all the olives in northern Persia was granted to a firm of Russian merchants, in a concession given to them by the Shah in 1890, and in order that no time may be lost in turning a profitable speculation to good account, a member of this firm has, it is said, been already carefully studying the various methods employed in Europe in the pressing and refining of the oil, the method in practice in the olive oil presses of Mar-

seilles having finally been selected by him. Every olive tree in Persia is subject to a government tax of four *shahis*, or about $1\frac{1}{2}$ l. English money.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock :—

MARCH 4.—J. HARRISON CARTER, "Modern Flour Milling." SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, will preside.

MARCH 11.—H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D., "Electricity in relation to the Human Body." W. H. PREECE, F.R.S., will preside.

MARCH 18.—F. H. CHEESEWRIGHT, "Harbours, Natural and Artificial." LORD ALFRED CHURCHILL will preside.

Papers for which no dates have as yet been fixed :—

"The Sources of Petroleum." By WM. TOPLEY, F.R.S.

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"The Use of Petroleum in Prime Motors." By WILLIAM ROBINSON.

"The Durability of Pictures Painted with Oils and Varnishes." By A. P. LAURIE.

"Bimetallism." By SIR GUILFORD MOLESWORTH, K.C.I.E.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock :—

MARCH 17.—SIR EDWARD N. C. BRADDON, K.C.M.G., Agent-General of the Colony, "Recent Development of Tasmanian Industries."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Papers for which dates are not yet fixed :—

LEWIS ATKINSON, "The Diamond Fields of South Africa."

C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

WILLIAM WYLDE, C.M.G., "The Opening of Africa."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investiga-

tion." The Right Hon. LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 30.—COL. J. O. HASTED, R.E., "The Perrier Project." The Right Hon. SIR MONTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, F.S.A., "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

POPULAR AFTERNOON LECTURES.

Friday afternoons, at half-past 4 o'clock :—

Captain ABNEY, C.B., D.C.L., F.R.S., "The Science of Colour."

February 27; March 6, 13.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

GISBERT KAPP, "The Electric Transmission of Power." Three lectures.

LECTURE III.—MARCH 2.—Limit of Distance to direct Current Transmission—Alternating Current Transmission—Synchronising Motors—Ferrari's Motors—Motors for Small Powers—Electric Machine Tools.

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

LECTURE I.—MARCH 9.—Photography as a branch of Technology—Methods of giving instruction in the subject—The preliminary training essential—Photographic materials—Silver and its compounds—Reduction and oxidation occur simultaneously—The forms of reduced silver; grey and black deposits—Supposed allotropic modifications of reduced silver—The haloid salts of silver; their behaviour towards reagents; influence of solvents; formation of double salts—The state of molecular aggregation—Order of reducibility.

LECTURE II.—MARCH 16.—The existence of sub-salts of silver—Coloured forms of the haloids—Photosalts—Colloidal organic compounds of silver—Silver albuminate and "gelatino-nitrate"—The prin-

ciple of emulsification—Other photographic materials—Photo-physical and photo-chemical change—Modification of crystalline form under the influence of light—The action of light on asphalt—Photo-chemical study of iron compounds—Photo-chemical study of mercury and copper salts.

LECTURE III.—MARCH 23.—The action of light on the silver haloids—Accelerators and retarders of photo-chemical decomposition—The invisible products of the action of light on the haloids—Sensitive films—The function of the vehicle in modern emulsions—The invisible effect of light on the haloids—The photographic image—Development and subsequent processes.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 2... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Gisbert Kapp, "The Electric Transmission of Power." (Lecture III.)
 Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
 Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. Arthur Rigg, "The Balancing of High-Speed Steam Engines."
 Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. V. H. Veley, "The Chemical Changes between Nitric Acid and Metals." 2. Mr. J. A. Wanklyn, "Further Researches on the Butter of the Cow."
 Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. A. A. Hudson's paper, "Recent Legislation as to Buildings and Streets in London."
 British Architects, 9, Conduit-street, W., 8 p.m. Mr. Somers Clarke, "The Fall of one of the Central Pillars at Seville Cathedral."
 Medical, 11, Chandos-street, W., 8½ p.m. General Meeting.
 Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Mr. H. J. Clarke, "Deontology."
 London Institution, Finsbury-circus, E.C., 5 p.m. Sir Howard Grubb, "The Telescope."
 Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m. Annual Meeting.

TUESDAY, MARCH 3... Royal Institution, Albemarle-street, W., 8 p.m. Prof. V. Horsley, "The Structure and Functions of the Nervous System." (Part I.) "The Spinal Cord and Ganglia."
 Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.
 Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. John Thornhill Harrison, "The Subterranean Water in the Chalk Formation of the Upper Thames, and its Relation to the Supply of London."
 Pathological, 20, Hanover-square, W., 8½ p.m.
 Sanitary Institute, 74A, Margaret-street, W., 3 p.m. Dr. A. T. Schofield, "Domestic Treatment of Disease." 8 p.m. Mr. J. F. J. Sykes, "General Powers and Duties of Inspectors of Nuisances."

Biblical Archaeology, 9, Conduit-street, W., 8 p.m.
 Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. O. Thomas, "A Collection of Mammals made by Mr. F. J. Jackson, in Eastern Central Africa." 2. Miss E. Sharpe, "The Butterflies collected by Mr. F. J. Jackson, during his recent Expedition in Eastern Central Africa." 3. Dr. R. W. Shufeldt, "The Comparative Osteology of the United States' *Columbidae*."

WEDNESDAY, MARCH 4... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. Harrison Carter, "Modern Flour Milling."

Entomological, 11, Chandos-street, W., 7 p.m.
 Archaeological Association, 32, Sackville-street, W., 8 p.m.
 Obstetrical, 20, Hanover-square, W., 8 p.m.
 Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. J. H. Paul, "The Prevention of Scale in Boilers."

THURSDAY, MARCH 5... Royal, Burlington-house, W., 4½ p.m.
 Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Miss E. Barton, "A Morphological and Systematic Account of the Fucaceae Genus *Turbinaria*." 2. Mr. George Murray, "New Species of *Caulerpa*, with Observations on the Position of the Genus." 3. Dr. John Lowe, "The Genus *Lernaeosresna*, a Parasitic Crustacean."
 Chemical, Burlington-house, W., 8 p.m.
 London Institution, Finsbury-circus, E.C., 6 p.m. Prof. E. Ray Lankester, "Sea Fishes."
 Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. Meymott Tidy, "Modern Chemistry in Relation to Sanitation." (Lecture I)
 Archaeological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

FRIDAY, MARCH 6... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Popular Afternoon Lectures.) Captain Abney, "The Science of Colour." (Lecture IV.)

United Service Inst., Whitehall-yard, S.W., 3 p.m. Lord Brassey, "Navigation and the Pilotage of Ships."
 Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. J. A. Fleming, "Electromagnetic Repulsion."
 Geologist's Association, University College, W.C., 8 p.m.
 Sanitary Institute, 74A, Margaret-street, W., 3 p.m. Dr. A. T. Schofield, "Microbes." 8 p.m. Mr. J. F. J. Sykes, "Objects and Methods of Inspection."
 Philological, University College, W.C., 8 p.m. Prof. Dr. A. T. de Lacouperie, "The Non-Chinese Languages and Writings of China."
 Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.
 Physical, Science Schools, South Kensington, S.W., 5 p.m.

SATURDAY, MARCH 7... Froebel Society (at the House of the Society of Arts), 2½ p.m.

Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.
 Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "The Forces of Cohesion." (Lecture IV.)

CORRECTION.—In the discussion on the paper on the Ordnance Survey, Captain Maclear is reported to have said that there was only one 25-inch map in the Isle of Wight. What Captain Maclear really stated was that there was only one such map in his parish, the parish of Cranleigh, Surrey.

Journal of the Society of Arts.

No. 1,998. VOL. XXXIX.

FRIDAY, MARCH 6, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. GIBERT KAPP delivered the third and concluding lecture of his course on "The Electrical Transmission of Power," on Monday evening, 2nd inst.

The lecturer dealt with the question of limit of distance for direct current transmission, and explained the principles of various motors by means of numerous diagrams. He concluded with a description of electric machine tools.

On the motion of the CHAIRMAN, a cordial vote of thanks was passed to the lecturer for his valuable course of lectures.

The lectures will be printed in the *Journal* during the summer recess.

POPULAR AFTERNOON LECTURES.

The third lecture of the course on "The Science of Colour" was delivered by CAPTAIN ABNEY, C.B., F.R.S., on Friday afternoon, 27th February.

Captain Abney showed how it was possible to match every colour by using one of the colours of the spectrum mixed with white light, and proved that any possible colour could be described (either directly or through its complementary) in a manner admitting of its reproduction at any future time, by simply giving the number of the wave-length of the pure colour required, and the proportion of white light to be added.

The fourth lecture will be given to-day (Friday), at 4 30 p.m.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1891 early in May next. The medal has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measure and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michael Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history,

which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michael Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the applications of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have hereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (now Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister, "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to HER MAJESTY THE QUEEN, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, F.R.S., LL.D., "for his achievements in promoting the Arts, Manufactures, and Commerce, through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

The Council invite Members of the Society to forward to the Secretary, on or before the 18th of April, the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

INDIAN SECTION.

Thursday, February 27, 1891; SIR CHARLES EDWARD BERNARD, K.C.S.I., in the chair.

The paper read was—

THE ECONOMIC DEVELOPMENT OF SIAM.

BY ROBERT GORDON, M.INST.C.E.

The Siamese are a branch of the great family of peoples who occupied the south-western countries of China before these were consolidated into the empire. The Chinese annals record that, 2,000 years before Christ, upheavals and transmigrations of the population took place; and, as the yoke of empire made itself more heavily felt, struggles and rebellions, ending in defeat, caused successive waves of the original peoples of Honan, Hupeh, Szechuan, Yunan, and Kweichow to flow southwards through and over the high plateaux of Yunan into Indo-China. From a very early date, the whole of the centre regions of this peninsula, from Asam south-eastwards to the Mekhong delta, was in the possession of powerful and closely-related tribes, who, under the name Shan, derived their origin from the north and north-west. The Annamites, Cochinchinese, and Cambodians, appear to have been the first comers; and, while dispossessing the primitive races, who are still to be found as Stiengs, Penongs, Khas, &c., in the mountains separating Siam from Annam and from China, by intermarriage and assimilation with these, were profoundly modified in physique and character. The main body of the Shans occupying the highlands and plateaux of Indo-China, still known as the Shan and Lao States, remained comparatively free from admixture with other peoples. They called themselves the "Tai," or Free, a name still common to the whole of the family; the Lao branches adding the word Yayee, or Great; and, when the Siamese separated themselves from the others, by emigrating from Chieng Rai on the Mekhong a century before our era, to settle in the upper valley of the Menam, they were called the Tai Lek, or little Tai, a name they still retain.

The records of the early Cambodian empire are lost; but under the names "Kam" or "Kmer," it established itself over the vast plains of the Mekhong, and held subject the lower lands of the Menam valley. Vast ruins of temples, palaces, and works of pomp in the province of Battambang, at Angkor, at Bassac, Pathai-soung near Korat, and other places, attest the vanity of the rulers and the degradation of the people. Such works could only be the product of abject slaves ground down by a conquering foreign race. It was first known to history in the third century of our era; and

in 1295, Kublai Khan, Emperor of China, sent an ambassador to renew the ancient relations, and obtain tribute. At this time, Angkor was the capital of a flourishing State. Two centuries later, two Portuguese travellers found the capital removed nearer the sea, the old capitals being abandoned and ruined, and the empire shattered. The French travellers, Mouhot in 1861, and Lagree and Garnier in 1866, visited and described the magnitude and imposing character of the ruins, and agree in their accounts of the Cambodians. "Pride, insolence, cowardice, servility, excessive idleness, are the attributes of this miserable people," says Mouhot. Garnier rightly attributes to the old system of government the persistent laziness which makes the Cambodian refuse to work more than necessary to procure a bare subsistence, though living in one of the richest countries of the world. Even the fishing of his coasts, and rivers, and the great lakes is done by foreign Annamese.

To the north-west the Shans founded the kingdom of Pong, before the Christian era, with its capitals in the Upper Irawadi. Its boundaries spread over the plateaux of the present Shan States, it colonised the main Irawadi valley northwards, from a short distance above Mandalay; conquered Burma, and held it in domination for centuries; occupied the States of Kachar, Manipoor, and Khamti; and in the 8th century established in the Brahmaputra valley the kingdom of Ahom, or the "unequaled," a word since corrupted into Asam. Pong existed with varying fortunes till the 17th century, when, after repeated struggles with China and Burma, it finally disappeared as a kingdom, only to live as a series of semi-independent Shan States, self-governing, and owing but a nominal suzerainty to their powerful neighbours. It says much for the vigour and self-reliance of the Shans that they still hold the whole of the fertile and profitable lands in the plains and plateaux of the regions they have once occupied; though irruptions of savage Kyens, Singphos, and Kachens have penetrated through them on the mountain crests; and they have retained their title of the "Free."

Midway in Indo-China, between these kingdoms of Pong and Kam, the Lao tribes established petty kingdoms, clinging at first mostly to the small valleys and hilly regions about the head-waters of the Menam and the course of the Mekhong, to the north and north-east of Siam. The kingdom of Chieng Mai was founded in the 7th century B.C. in the

western branch of the Menam—the Meping. The mass of the Tai-Yayee, or Lao tribes, continued to struggle eastwards and southwards, along the course of the Mekhong; and in the 4th century A.D. their armies fought with the Annamese on the borders of Tonquin. In the 13th century, they established a strong kingdom at Winchang, on the Mekong; and early in the 18th century emigrants from this State founded Luang Prabang to the north, and Bassac to the south-east. The difficult nature of the country the Lao tribes occupied prevented the formation of a great and powerful kingdom, and they were broken up into numerous petty states, often at disunion with each other. But they united from time to time for aggressive purposes, and repeatedly attacked the northern provinces of Kam and Siam, in endeavours to force a way for themselves through the Mekhong-Menam valleys to the sea. In the 15th century, the Lao kingdom of Winchang reached almost to Ayuthia; and in the 17th century they made desperate efforts to force a passage through Cambodia. All their efforts failed.

The youngest of the great Shan peoples, modestly calling itself the little Tai, which established its home two thousand years ago on the Me Yome and the Menam Yayee, the centre and east branches of the Menam, had a hard struggle for the first fifteen centuries of its existence. The motto of modern Siam is “*Koy-bra-deo*”—*Festina lente*—Wait a bit; and the practice of active patience seems to be embodied in its history. The records of the early progress are lost, probably in the destruction of Ayuthia; and positive history only begins in 1350, with the founding of that city. Previous to this time, a succession of cities—Sawankaloke, Peechai, Pitsanaloke, &c.—had been the capital, which always moved a step southward, into the richer plains and more navigable channels of the river. The previous occupiers of the country and the Cambodian Empire disputed this progress step by step until the 13th or 14th centuries, when all Southern Siam and the north part of the Peninsula were added to the kingdom. When the capital was moved to Ayuthia, on the site of an old Cambodian city called Lawek, Siam had consolidated its power over a large extent of country, but its boundaries are not known.

Siam only became known to Europe in the 15th century. The first direct communication between Europeans and Siamese took place in 1511, when Albuquerque, who was besieging

Malacca, sent the Portuguese lieutenant Fernandez as ambassador to the king of Siam to ask him for assistance. The king promised to help, and sent presents; and for a century the Portuguese monopolised a friendly intercourse with Siam, many entering the king's service. In 1604 the Dutch intervened, and in a short time superseded the Portuguese in their commerce and friendly relations; but their influence disappeared, and Sir J. Bowring found no traces, in 1855, of their ever having been in Siam. In 1611, the English East India Company sent the ship *Globe* to Siam with Factors, who were favourably received, and intermittent trade was carried on till 1687, when England proclaimed war against Siam. At that time Tenasserim belonged to Siam, and the British officer, Captain Weltden, took the proclamation to Mergui, and waited there for an answer from Ayuthia. While under a flag of truce he seized a Siamese ship, and destroyed some fortifications which he believed threatened him. This so enraged the mob in Mergui that they massacred over fifty Europeans, mostly English and Portuguese. The king of Siam severely punished the leaders of the riot, and even after the war broke out, permitted individual Englishmen to continue trading. Spain made abortive attempts to negotiate with Siam; and France was more successful, but with disastrous results to both parties. Louis XIV. and the king of Siam twice exchanged embassies. The last French embassy was accompanied by 1,400 troops, sent to support the designs of a Greek adventurer, Phaulcon, who had been made prime minister of Siam. He aimed at bringing Siam under French influence, or was suspected of this by the Siamese, and, when the king died in 1688, a revolution broke out, Phaulcon was killed, the Portuguese and the English were imprisoned, and the French troops attacked and ultimately driven from the country.

A new dynasty occupied the throne, and intercourse with Europeans was renewed; but incessant civil wars weakened Siam, and a series of struggles with Burma culminated, in 1767, with what seemed to be the complete obliteration of Siam as a kingdom. Ayuthia, the capital, was destroyed, the king and his family taken prisoners, and his dynasty extinguished; the Shan and the Lao States became independent, and even Korat set up as a separate kingdom, under a prince of the late dynasty; Tenasserim was annexed to Burma, to become, in 1824, a British province; and the hold on the Malay States was

relaxed. The Siamese armies were dispersed, and the government shattered.

A general, Phya Ták, of Chinese descent, nevertheless gathered together the remnants of the troops, and drove the Burmese out of Ayuthia in 1767. He assumed the throne in 1768, re-conquering Southern Siam, Korat, Northern Siam, and the Malay States, successively. He made Bangkok the capital in 1769, and founded modern Siam. The first king of the present dynasty began to reign in 1782. A Chinese invasion of Burma relieved Siam from the Burmese for a time, and the occupation of Martaban by the British, in 1824, effectually prevented further Burmese invasions of Siam. The peace thus secured from outside wars was utilised to reconstruct the kingdom. Chiengmai, and all the Lao States to the confines of Yunan, Tonquin, and Annam, were conquered and added to the kingdom. Winchang was the last State to make a desperate resistance, but was finally destroyed in 1828; and Luang Prabang and Bassac were brought under direct Siamese rule, although the old chiefs are allowed to retain their titles and positions. The Laos had driven the Cambodians out of their Northern Provinces, which were annexed to Siam, and what remained of the old empire of Kam was compelled to acknowledge the protectorate of Siam.

While the Siamese were so pre-occupied by their own affairs, little encouragement was given to foreign intercourse; and the history of the country remains a blank for 150 years. Mr. Crawford was sent to Bangkok by the Governor-General of India, in 1822, to try and negotiate a treaty, but was unsuccessful; but after the taking of the south-eastern provinces of Burma by the British, who thus became the neighbours of Siam, a treaty was negotiated by Captain Burney, in 1826, between England and Siam. This, however, remained a dead letter, as the export of both rice and teak, the great staples of trade of Siam, was prohibited; and most other articles remained Royal monopolies, while heavy dues were levied on English vessels, and all foreigners were subject to the laws of Siam. In 1850, Sir James Brooke unsuccessfully attempted to re-open negotiations; and it was not till 1855, after the annexation of Pegu to the British Empire, that a new and satisfactory treaty was agreed to between the father of the present king of Siam and Sir John Bowring, on behalf of the Queen of England. This was followed by similar treaties with other European nations, and with the United States.

The principal provisions of the treaty are as follows:—British subjects are permitted to reside and to trade freely in Siam. Their interests are placed under the regulation of a Consul who decides cases in which they are concerned by British law. On registration, and with a pass from the Consul, unrestricted travelling is allowed in the interior. All duties on shipping are abolished. Import duties not exceeding 3 per cent. *ad valorem* are substituted for the irregular imposts of former times, and only one duty, either in transit or export, is placed on goods exported. Rice and teak can be exported with a duty on the former of about 5s. per ton; and on the latter of from 5s. to 8s. per log. All monopolies, except opium, were abolished; and this is imported free from duty, but can only be sold to holders of Government licenses. Practically, all foreigners enjoy complete liberty under the protection of their own Governments. The freedom from jealousy in the nature of the Siamese; their absolute tolerance in religious matters; and the friendly relations of the Government and the people with foreigners, have permitted a progressive development of the resources of the country, and of its commerce since 1855, and promise a still further extension.

To understand this, the actual situation of Siam, its peoples and its Government, may be briefly reviewed. Important changes have occurred on its borders since 1855. The last of the independent Malay States, Pahang, passed under British protection in 1888. Upper Burma was annexed in 1886, thus bringing the old kingdom of Pong under the same rule as that of Ahom, and completing the neighbourhood of Siam on its west to the British empire. In 1859 France took Cochin China. In 1863, the protectorate of the degenerate kingdom of Cambodia was transferred from Siam to France. Subsequently, Annam and Tonquin were brought under French rule; and at present the whole of Indo-China, from Assam to the China Sea, is divided between England, Siam, and France.

With the exception of small and unimportant areas, the boundaries of Siam are now clearly defined. Its extreme length stretches over 17 degrees, from lat. 4° N to beyond 21° N, or about 1,200 miles. Its breadth is about 750 miles, from long. 98° to 109° E. In shape it resembles a water-dipper ladle, the handle being the Malay Peninsula, and the bowl lying north of latitude 13°. The area of the whole kingdom I calculate to be about 360,000



square miles, of which 60,000 are in the peninsula. Up the centre of the peninsula runs a range of hills, which disappears about lat. 9°, leaving a flat stretch of ground from sea to sea. Shortly, another range begins at sea level, and serves as the boundary between the British possessions and Siam; continually rising till, to the north of Maulmein, where the boundary comes down to the Salween, a pass over the mountains, near Mainlonggee, is 3,609 feet high, the crest and peaks rising still higher to the north. The boundary turns east, round the head-waters of the Menam, and crosses the Mekhong, to follow the southern slopes of the Yunan plateaux, where it runs with that of China, although the region is occupied by independent tribes of Lolos and Khas. The country held here by the Lao tribes is subject to Siam, and the boundary soon turns south-east, to follow the water-shed of the high range of mountains which separate Siam from Annam to lat 13° N. The whole of the main part of Siam, which I have called the bowl, except its southern front, is thus surrounded by a fringe of mountains and high lands, rising to levels of from 3,000 to 8,000 feet above the sea. Almost the whole of the interior country consists of two great plains, the one a little above sea level occupying the valley and delta of the Menam, and then turning eastwards to join the great delta region of the Mekhong on almost the same level. The other, or the Korat plain, to the north-east of the first one, appears to have been lifted bodily up from the level of this in a long-past age, by forces mostly acting along two lines which meet at a point some fifty miles north-east of Bangkok, and run north and south and east and west from there. Two ranges of hills follow these lines, and rise from 1,300 to 4,000 or 5,000 feet above sea level. Their outer slopes are extremely abrupt, while the inner ones are graded gently down to the elevated plain where Korat stands. The plain itself stands from 800 to 1,000 feet above sea level near its outer rim, and to the north, where the Mekhong enters it; but it gradually falls towards and with the river to the rapids of Muang Khong, at a height of from 300 to 400 feet above sea level. Both ranges continue beyond the river, which has frayed itself a passage through them. Garnier says its course is navigable from Muang Lem, in lat. 22° 42' N., for over 800 miles to Muang Khong, whence a series of rapids for 120 miles are grave obstacles to navigation. Tidal level is then reached at Krakra, about 250 miles from the sea.

A short east and west range of mountains in lat. 20° joins the hills just mentioned to the great boundary range to the west. A pass over this between Chieng Mai and Chieng Hsen is 4,235 feet above sea level, but shortly to the east another pass is at 1,643 feet above the same height. These three ranges form the upper valleys of the branches of the Menam, which are thus effectually secluded from invaders from west, north, and east, and enabled it to become the cradle of the Siamese nation. The descent to the plain lands is rapid. Chieng Mai stands about 1,000 feet, Rabeng 400 feet, above sea level. Here the Meping becomes navigable to steamers from May to December; and to large boats for the remaining months. The other branches, the Me Yome and Menam Yayee, are navigable during the rains to nearly 500 miles from the sea; and for small boats, all the year round. The three branches unite above Paknam Pho, about 200 miles from the sea. From this point to Bangkok, large steamers could travel all the year round, if the channel were kept in good order. Above and near Ayuthia, where a branch from the north-east, navigable to Saraburi in the dry weather, and beyond it in the rains, joins the main channel, this is broken up into different arms; one of which takes a separate course to the sea by Pachin. The others re-unite, and form a fine river, 600 to 1,000 feet broad, with clear, well-defined channel and moderate currents, which, for the last 40 or 50 miles of its course, flows to the sea with depths of not less than six fathoms, so that the largest vessels could lie close to the banks. Unfortunately, a bar, with only 14 feet of water upon it at high tides, obstructs the entrance. Similar bars block the mouths of the Meklong and Bang Pakong, hand-maid rivers of the Menam, whose waters unite with it in a common marine delta in the bay, outside of Bangkok. The valleys and plain lands of these three rivers constitute Siam proper.

The climate varies considerably over this great extent of country, and very few precise data exist. A statement of the rainfall at Bangkok for eight years (*see* p. 288) gives an average of 54½ inches, with a greatest rainfall in one year of 70 inches. At Amherst, near Maulmain, the mean fall for several years was 188 inches.* Dr. Thorel† gives 114 inches as the average rainfall of Saigon. In all these cases the fall occurs mostly in the seven months from May to November, but in

* Burma Administration Report for 1888-9.

† C. Thorel.

BANGKOK RAINFALL, 1882 TO 1890, REGISTERED AT THE BORNEO COMPANY'S OFFICE.

YEAR.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1882.....	0'50	...	0'21	4'52	5'92	3'78	8'43	3'07	14'15	11'56	1'50	...	53'64 inches in 1882
1883.....	...	0'63	...	3'06	7'44	9'69	2'10	5'76	8'57	3'44	1'52	...	43'21 „ 1883
1884.....	1st January to 30th June.					7'	5'29	3'57	6'18	8'49	3'23	...	33'76 „ 1884
1885.....	0'10	3'62	0'12	1'35	1'52	8 88	6'78	10'96	14'12	9'06	3'35	...	59'76 „ 1885
1886.....	...	0'52	0'95	0'72	7'72	8'49	10'97	4'02	16'41	12'85	3'12	...	65'77 „ 1886
1887.....	1'79	2'25	0'87	2'39	8'76	4'19	7'97	8'75	9'61	6'98	1'56	...	55'12 „ 1887
1888.....	No register kept.												
1889.....	5'10	...	1'15	1'04	6'97	5'81	3'88	10'64	16 07	11'14	6'76	1'51	70'07 „ 1889.
1890.....	0'50	0'50	...	1'40	8'52	5'68	4'01	12'14	...	...	...	...
Average per month.....	1'14	1'07	0'47	2'49	6'69	6'64	6'18	7'44	12'16	9'07	2'99	0'21	54'33 average for seven years.

Bangkok the heaviest average falls are in September and October, with occasional heavy showers in the dry season. The northern mountains near Chiangmai, and the valley of the Mekhong beyond, are reported to have abundant rainfalls; but the broad plains of Korat do not have so great a supply. While travelling to the south of Korat in January, 1890, I experienced heavy rain for three or four days and nights; and sufficient for regular cultivation is said to fall in the wet seasons. The Cambodian plains, to the south of this high land, suffer from want of water, as the ground is so hard, from an admixture of iron, that it will not retain enough for cultivation. Generally speaking, the whole of Siam is healthy, despite the great heat of the sun in the summer months, and the heavy rain; but there are certain localities, especially in the slopes and near the bases of the mountains, where malarious fevers prevail. It is also noticed that where the soil or subsoil is clayey fevers exist. Bangkok itself rests on a permeable loam, with a great depth of soft river silt beneath it; and, despite grave defects of water supply and drainage, is deservedly reputed to be a healthy city. Improper food and drink, and indiscretions in exposure to the sun, or to the sudden changes in the temperature, are responsible for many of the diseases attacking natives and Europeans. The natives are less able to withstand the sudden changes from heat to damp and cold than Europeans, probably because they are not so well provided with suitable clothing or fortified with food. The immense Dong-Pya-Fy, or Forest of the King of Fire, which covers the southern range of hills bounding the Korat Plain, is dreaded by the Siamese as the reported haunt of the spirits of fever, dysentery,

and death. Many Europeans have enjoyed perfect health for many years, some after undergoing severe hardships in the forests and mountains. South-west winds prevail from June to November, and north-east winds during the earlier part of the cold weather; but local winds from the south-west blow often during afternoons in the hot months of April and May, sometimes bringing showers of rain.

The estimates which have been made of the numbers of the population and of the various peoples of Siam vary very much. Crawford considered it to be, after careful inquiry, not more than 2,790,500, of whom 440,000 were Chinese, 840,000 Laos, and 195,000 Malays. Pallagoix made it 6,000,000, of which 1,500,000 were Chinese, and Malays and Laos each 1,000,000. Bowring reduces the total to 5,000,000 at most. Boch guesses it to be nearer 30,000,000. M. Donner, Belgian Consul at Singapore, whose excellent account of Siam is published in the "Recueil Consulaire" for 1890, raises the total to 12,000,000, of whom 3,500,000 are Siamese, 3,500,000 Chinese, and 2,600,000 Shans, Lao, and Burmese. It is extremely difficult to arrive at a true estimate, even by the Siamese authorities; although adult males are supposed to be numbered for service in the army, for *corvées*, or for poll tax, as the Chinese. Slaves are not included in any of these classes; and the numberings in the remote districts are not likely to be accurate or regularly submitted, especially amongst the Malays, the Shans, and the Laos, not to mention the savage hill tribes. The numbers of the Chinese are apt to be exaggerated, as they are everywhere in evidence as workers, as traders, and as travellers. They come to Siam as adults, without women or children. In 1887, 12,100

arrived by steamer, in 1888 over 14,000, and with others coming by junks or overland, an average of not less than 15,000 must come to Siam every year. Of these, probably one-third return to China with their savings. Probably 4 per cent. die annually. Some settle, and marry Siamese wives, their grandchildren becoming Siamese subjects. It is impossible that there can be more than 500,000 Chinese in Siam, of whom probably 200,000 are in Bangkok, 100,000 in the Malay States, and the others distributed over the country. It is easier to estimate the population by areas than by race. Siam proper, including the plains of the Menam and its sister rivers, some 50,000 square miles in extent, is comparatively densely populated, almost as much so as the plains of Pegu. It cannot have fewer than 3,000,000, including 500,000 in Bangkok. Of these, 2,500,000 are Siamese, or Lao, the remainder being Chinese (300,000), Malays, Peguans, Indians, &c. Dr. Cheek, a competent observer, estimates the population of Chiang Mai as 600,000, and of the various Lao States as 2,000,000. The great plain of Korat, where Lao, Siamese, and Cambodians struggled so long, cannot have less than 1,000,000; and Siamese Cambodia at least another 1,000,000. The semi-independent hill tribes of Stiengs, Khas, Lawas, Tongsus, and Karens, who live in the boundary ranges, probably number between 200,000 and 500,000 in all. The British Malay States average 16 persons to the square mile, or, including the Straits, 38 persons. The Siamese peninsula probably has 20 per square mile at least, or 1,200,000, of whom one-half are Siamese. The Europeans and Americans in Siam are under 500 in number, 40 per cent. being British; and the native British subjects from Burma, India, and the Straits are nearly 40,000 in number in Siam. The total population I estimate to be between 9,000,000 and 10,000,000, of which nine-tenths are of the closely-related families of Shans, Lao, Siamese, and Cambodians, the pure Siamese being one-third of the whole.

The close affinity in race and family of this great mass makes the task of the Siamese Government easier, in moulding the various peoples into one homogeneous nation. The manners, the customs, and the institutions of the various tribes and states resembled each other in kind while differing in degree. The degrading tyranny of the old empire of Kam was an oppressive modification of the patriarchal system prevalent amongst the Shan

peoples for thousands of years. It subsisted in theory even in the highland clans of the Shans, where nominally the chief controlled the lives and properties of his people; but practically these remained the "Free." In the Lao States the system has always prevailed in an onerous form, and state serfage and *corvée* have been used for the benefit of the reigning families. In the old kingdom of Siam the severe struggles for existence and for dominion made conscription and the *corvée* indispensable conditions, so that the present government has inherited systems of serfage and slavery, nominally placing the lives and properties of the whole nation under the control of the king; but actually modified very considerably in practice by custom and by the wise and humane measures which the king and his government are introducing. All adult males are liable to conscription for the army, except the slaves. The slaves are of two kinds—debt slaves and slaves by inheritance; the latter of these may be descendants of prisoners of war or of raids in the outlying provinces, or may be descendants of debt slaves where the original transactions have been forgotten by lapse of time. The debt slaves are those who voluntarily make over the personal service of themselves or their families to their creditors in lieu of repayment of moneys due. In all cases the slavery is of the lightest and easiest kind, almost always domestic; the slave being secured against ill-treatment by law; the severest punishment the master can inflict being the wearing of irons for running away. Light as it is, the institution is infinitely degrading both to the slaves and to the owners; but it only exists to any extent in the larger communities in remote places, the ordinary village life being free from anything beyond debt service. Sometimes it is resorted to in order to escape the conscription and *corvée*; and so is injurious to the State. The present King of Siam has always been solicitous to put an end to it, and soon after acquiring power, issued a proclamation by which all persons born of slaves after 1868 should become free on attaining their twenty-first year, so that, if the law be vigorously enforced, the end cannot be far off. The system of State *corvée* is most unequal and injurious, without bringing the Government any real advantage. All adult men are liable to be called on to work for the State for one month in every four, except at seed-times and harvest. Practically, the result of this is that all along the principal highways, whether by road or water, the men

are called out in a measure which is burdensome, mostly for transport work, getting nothing but food in return. The large majority of the people remote from these high roads escape often from their burdens; and it is said the *corvée* is used at times not so much for the State service as for the pomp or private work of officials. I must testify, from my own travels, that there was little evidence of extensive misuse of the *corvée* by the officers; but that its effects on the people was bad, in compelling well-to-do people to abandon their own affairs, and perform 'carters' or porters' work for a time. It must be acknowledged, however, that in remote parts of this country, where means of transport cannot be hired, compulsory measures must be exercised, to procure them for State service. Throughout India, in the British service, this is recognised and enforced, but adequate payment by the officials is compulsory. It is probable that, if the Siamese Government insisted on full payment being made for such service, a sufficient supply would always be ready on the main routes through the country, as Chinese traders can always procure it on payment. The king himself has shown an honourable example, in paying above market prices for land taken up for his own requirements, and in paying for services for State ceremonies in Bangkok. His difficulties in dealing with these matters and with slavery can be appreciated, when it is known that even the British Government cannot abolish slavery and the *corvée* in an off-hand manner. Both continued in some of the Malay States until the British Queen's Jubilee year, 1887, and still exist under our flag in Pahang, almost identical with these institutions in Siam. The *corvée* can be avoided in Siam by a yearly payment of 6 ticals, or about 10s. If this, or a smaller payment, were made universal for all grown men, whether slaves or not, the State would reap an immense profit, as one-tenth of the sum would pay for all *corvée* work. The Chinese already pay a poll-tax instead of *corvée*. In Lower Burma, a poll-tax of from 5s. to 8s. has always been enforced, bringing in an annual revenue of over £300,000 on a population of under 4,000,000.

The form of government is, theoretically, absolute monarchy. In practice, customs tenaciously adhered to for ages have tempered this, and the enlightened and liberal policy of the present king and his father is resulting in a radical change, which will probably result in constitutional and, eventually, representative government. In 1874, a treaty

was made between Britain and Siam, in which the authority of the latter over the Shan and Lao States in the north was confirmed. Since then there has been a gradual substitution of the power of the central Government in Bangkok for the arbitrary and capricious rule of the several chiefs of those States, and commissioners, supported by armed forces, now control and regulate the local authorities. A similar condition has been brought about in the Siamese Malay States, which are now in a closer and more direct dependence on Bangkok than ever before. The old seclusion of the remote provinces is thus destroyed, and a uniform and harmonious system has been substituted by the continuous circulation of the new and old officials between the capital and the districts. There is thus a better knowledge of the affairs and the requirements of the whole kingdom in Bangkok. The king has thus formed a grand council of the ministers, the principal nobles, officials, and representatives of the different regions and interests of the kingdom, where all questions of first importance are discussed. No executive responsibility is vested in the council, but affairs are freely ventilated. Progress has been made in the different ministries. The finance minister proposes a budget of receipts and expenses, which, however, is not yet made public. The army and navy are under a Minister of War, assisted executive by a commander-in-chief, who is introducing the latest European arms, drill, and discipline. The army is rather a militia than one suited for continuous service. Probably 70,000 men are borne on the lists at one time, mostly recruits, called up for three months' drill; with from 10,000 to 20,000 in active service in Bangkok and outlying districts. Ministries of laws, home affairs, agriculture and public works, &c., have been established within the last few years. Surveys under scientific direction are carried out. Canals have been dug in the plains from near Bangkok to neighbouring channels; the customs are being re-organised by an officer lent by the London Custom-house; telegraphs have been constructed on a few lines through the country, and are being popularised by cheap rates; schools and colleges, both governmental and under French and American missionaries, are liberally supported with excellent results, the king lately declaring publicly his desire that the English language should form a principal subject; hospitals for Europeans and for natives have been established; and extensive law-courts. Young men have been sent for

several years to Europe and to America for thorough education in Western ways; and a framework of modern civilization has been designed, and, in a manner, constructed, which can subsequently be filled in by the united and persistent efforts of the king, his government, and the people.

It is too early just yet to look for results from efforts of this kind. This influence hardly extends beyond Bangkok. The transition from old ways to new ways must be gradual, and it is obvious that the Siamese

Government recognises this, as it proceeds tentatively in much-wanted improvements. But the time has now come when it must take measures to keep progress with its neighbours, who, in Burma, in the Malay States, in Cochin-China and Tonquin, contemplate, or are actually carrying out, projects which may affect Siam. The Government is fully alive to this, and is giving careful consideration to a number of projects for the development of the resources of Siam itself, which may enable it to keep pace with the countries around it.

TABLE I.—TRADE OF BANGKOK, SIAM, FOR 1888 AND 1889.

With	1888.			1889.			
	Imports.	Exports.	Totals.	Imports.	Exports.	Totals.	
	£	£	£	£	£	£	
Singapore.....	810,013 71'1	886,329 32'7	1,696,341 44'1	1,001,917 66'8	785,451 36'2	1,787,368 48'7	Averages of the ten years, 1880-89.
Hongkong	286,526 25'2	1,168,329 43'0	1,454,855 37'7	407,984 27'2	805,437 37'0	1,213,421 33'1	Exports ... 1,918,967
Europe	14,697 1'3	566,690 20'3	581,388 15'0	59,680 4'0	504,046 23'3	563,725 15'4	Imports ... 1,262,142
Other countries	27,751 2'4	92,339 3'5	120,198 3'2	29,560 2'0	75,242 3'5	104,802 2'8	Difference 656,825
Total	1,139,087 100'	2,713,687 100'	3,852,782 100'	1,499,141 100'	2,170,176 100'	2,669,316 100'	Total '..... 3,181,109
Treasure	672,913	9,984	682,889	94,059	116,103	210,163	
Grand total.....	1,812,000	2,723,671	4,535,671	1,593,200	2,286,279	3,879,479	

TABLE II.—COMPARATIVE STATEMENT OF PROGRESS OF SIAM AND OF LOWER BURMA.

Year.	BURMA.						SIAM.		
	Rangoon.			Other Ports.			Totals for Lower Burma	Bankok.	Peninsula.
	Imports.	Exports	Totals.	Imports.	Exports.	Totals.			
	£	£	£	£	£	£	£	£	£
1861-2	1,042,115	864,824	1,906,939	776,885	1,323,470	2,100,325	4,007,264	not known	
1881-2	3,740,800	3,521,700	7,262,500	988,840	2,461,407	3,450,247	10,712,747	2,690,900	not known 1881
1887-8	6,359,000	4,256,900	10,715,000	1,048,280	2,346,400	3,394,680	14,110,000	4,535,671	1,367,758 1888
1888-9	5,918,200	4,332,700	10,251,000	990,500	1,777,500	2,768,000	13,019,000	3,879,479	not known 1889
Total—£5,993,429 for 1888									

TABLE III.—EXPORT OF RICE AND OF TEAK FROM INDO-CHING COUNTRIES, DURING THE YEARS 1888 AND 1889.

PLACE OF EXPORT.	RICE.				TEAK.			
	1888.		1889.		1888.		1889.	
	Tons	Value in £	Tons.	Value in £	Tons.	Value in £	Tons.	Value in £
Saigon, Cochin China	506,287	2,152,015	281,971	1,567,629	...	...	...	...
Bangkok, Siam	449,446	2,104,849	303,000	1,433,328	29,538	156,772	43,146	254,159
All Ports, Burma	899,010	4,026,100	712,422	3,475,360	36,216	242,800	49,750	406,600
Rice duty, Burma ...	...	£337,400	...	£269,400	...	...	...	...

TABLE IV.—TRADE OF BRITISH MALAY STATES, FOR 1888 AND 1889.

	1888.			1889		
	Imports.	Exports.	Total.	Imports.	Exports.	Total.
Perak, Lilangor, Sungei, Ugong, } Negri, Sunbitan	£2,887,900	£3,297,350	£6,185,250	£2,656,533	£3,351,967	£6,008,500

Some statistics of the progress realised by Siam and her neighbours since 1860, when they were all open to foreign trade, will permit the value of the contemplated improvements to be appreciated. Table I. gives the trade of Bangkok for 1888 and 1889, compiled from the official returns. These are only approximate, being made from the assumed values at the Customs. The greatest yearly amount was £4,535,671 in 1888, that for 1889 being £3,879,479; and for the years 1880 and 1881 it was £2,674,306 and £2,690,900 respectively. The extraordinary feature of the Table is that it shows the exports to be always about 50 per cent. greater than the imports, and this with regularity during all the ten years 1880 to 1889; the average total of which is £3,181,109. Hong-Kong obtains two-fifths of the exports, and sends about one-fourth of the imports, excluding treasure. The direct import trade from Europe is small—1·3 per cent. for 1888, 4 per cent. for 1889. This is due to the obstacle of the bar at Bangkok, causing the transhipment at Singapore from large vessels to 600 to 900 ton steamers, of goods for Bangkok. The imports from Singapore are 71 and 67 per cent., the exports 33 and 36 per cent. for 1888 and 1889 respectively. With other countries the average trade is 3 per cent. of the whole. Most of the treasure is exchanged with Singapore. Details are wanting of the foreign trade of the Siamese peninsula; but in 1888 the commerce with the Straits Settlements was an import of £614,226, and export of £753,532, the excess still being on the side of the exports. No explanation is given in consular reports of this excess, which is probably due to unrecorded imports of treasure.

For comparison, the development of the trade of Lower Burma under British rule since 1861-2 is given in Table II. In that year, the total amount was £4,007,264. In the 20 years to 1881-2 it had increased to £10,712,747; and in 1887-8 and 1888-9, it was £14,110,000 and £13,019,000 respectively.* Most of the increase occurred in Rangoon, the average increase of the other ports, including Akyab, Bassein, and Maulmein, with large and important provinces behind them, being about 50 per cent. In the earlier years, the exports exceeded the imports for the whole province; but, in the last two years, the imports were larger by about 14 per cent. This was probably due to railway extensions, and

pay of troops and establishment in Upper Burma. No direct comparison can be made between Burma and Siam from these figures, for the following reasons:—1. The teak produce of the Siamese forests on the Salween is exported from Moulmain. 2. The sea-borne trade of Upper Burma passed through Rangoon. In 1881-2, the total trade across the frontier was about £3,000,000; in 1887-8, it was £4,355,000; and in 1888-9 it was £4,741,000, probably one-fourth of which did not pass through Rangoon. Making all allowance for this, we find that the trade of Rangoon increased from little more than zero in 1852-3, to over £10,000,000 in each of the last two years given for the lower province alone, and to over £13,000,000 for the whole trade, against an average increase in Bangkok, from little more than zero in 1855, to £4,000,000 in 1888 and in 1889. Table III. shows the progress of the rice trade to the same dates for Saigon, which was opened to trade in 1859, for Bangkok, and for Burma. For 1888, the total values are about £2,152,000, £2,105,000, and £4,000,000 respectively; for 1889, £1,568,000, £1,433,000, and £3,475,000; Burma more than doubling her rivals in production, as large quantities of rice are sent to Indian ports. The rice production figures are most significant, as they indicate more truly than any other the relative welfare of the different peoples, and the economic progress of these states; as it is in each case the staple article of export; and its cultivation covers nine-tenths of the agricultural area in each country. In teak, Siam about equals Burma, in 1888 and 1889, as a portion of her exports passes through Maulmein, and is credited to Burma. Its production is an accident of position, and affects but a few people.

It is evident that, tested by the rice or by the total trade volume, Siam holds her own with Saigon and with all the parts of Lower Burma, except Rangoon, in the progress made during the last thirty years. But Rangoon, and all the regions dependent on it, have progressed from twice to three times as rapidly in that time, the principal progress being made in the province of Pegu itself, with its great delta plains of the Irawadi and the Sittang. On careful examination there is only one efficient cause to be found for this difference of development. The delta plains neighbouring Saigon and Bangkok, and Maulmein and Akyab, in Burma, are as rich as those about Rangoon, and water communication is equally easy. The markets of the world are equally

* The 1861-2 figures are calculated at 10 rupees to the £ sterling. In all the other figures the equivalent values of 13·5 rupees and 6 Mexican dollars to the £ sterling are used.

accessible. The 2,000,000 to 3,000,000 of population of Pegu are no more industrious than the 6,000,000 to 9,000,000 of Siam, or those of Cochin-China. The land tax in Siam is from one-half to one-third what it is in Burma, and the cultivator is free from all vexatious interference. There is only the one thing, so far as known, to make the difference shown. In the province of Pegu there has been a large and steady expenditure for over thirty years on public works for developing the resources of the province. From £250,000 to to £500,000 yearly have been spent in the whole of Burma—probably one-half or more of it on administrative or protective work, equally divided throughout the country; but almost all the reproductive works, such as embankments and canals, and roads and bridges to open up the remote parts of the country, have been far more lavishly bestowed on Pegu than on any other part of Burma. Since 1860, from £3,000,000 to £6,000,000 sterling have been spent by the supreme Government on such works in Pegu; besides £3,000,000 on 350 miles of railway. And the self-governing districts spend large sums annually in third and fourth-rate country roads and minor improvement works of bridging, embankment, and drainage; besides the large sums spent by municipalities like Rangoon, &c. On the Irawadi embankments some £500,000 have been expended, reclaiming over 2,000 square miles, or 1,250,000 acres of rich land. So remunerative are some of these works that one—the Maoobin embankment—on an island of the delta, reclaimed over 300 square miles at a cost of £20,000; and is now paying a revenue in land tax and rice duty alone annually exceeding that sum. When the Burmese first saw large sums of money poured into these hopeless jungles, they said the English were an amiable, benevolent people to lavish their cash in finding work for the poor. In sharing the results they now recognise other qualities in the English. The final result is that the value of the trade of the provinces averages about £4 per head per annum.

In Siam the expenditure on works for developing the resources of the country is almost nothing up to the present time. Canals exist about Ayuthia and Bangkok for the benefit of these places; and the Menam is united to the Meklong and Ban Pakong by small canals, which are not kept in proper order. Another canal runs north from Bangkok, thirty to forty miles. These open up the country, and are encouraging examples of what may be done,

but could be multiplied with advantage. One military road to Cambodia was made forty years ago, but is now mostly overgrown with jungle. Hitherto, trade has developed by the unassisted resources of the country, which are magnificent. Had the Siamese Government, during the last thirty years, spent judiciously on public works for developing the country as much money as has been spent on similar works in Pegu, the volume of trade would have been as great, if not greater, to-day. The reproductive character of such work is now universally recognised, not only by the Siamese, but by their neighbours. Roads, irrigation works, and railways are being pushed on with vigour in Upper Burma. Over 200 miles of the latter have been constructed there since 1887, and surveys for some 500 more are being carried out. In the British Malay States the system inaugurated by Sir Andrew Clarke, in 1874, is being extended with excellent results. Several railways and many roads are in progress. Already the trade volume exceeds £6,000,000 sterling yearly, from an area of 13,600 square miles, and a population of under 350,000; an average of £17 for each person. The French in Cochin-China and Tonquin are also alert, and projects are being pushed forward.

Numerous proposals have been made affecting Siam, both from within and without. Only a brief enumeration of the more important of these is possible at present, with a few remarks on each.

I. Water communications.—(a) *Harbour for Bangkok at Koh-si-Chang.*—Surveys have been in progress for making piers and groynes to convert the open roadstead between the islands into a harbour, secure all the year round for the largest vessels. It is 50 miles from Bangkok, and lighters convey rice at a cost of under 3s. per ton to it. The project has not yet been worked out, but is favourably considered.

(b) A project has been suggested for lifting vessels up to 3,000 tons burden into 12 feet draught, and towing them over the bar into and out of Bangkok river. The sheltered position of the bay outside Bangkok favours this project, which requires working out in detail. This, if successful, would dispense with the expensive works at Koh-si-Chang, and convert Bangkok into a splendid port, without causing the inflow of sea-water to spoil the drinking supply of the city—the principal objection of the Siamese to cutting through the bar.

(c) The improvement of the navigable chan-

nels of the Menam, so as to permit steamers of light draught to use them all the year round. At present, snags, sand-banks, and branching channels cause obstructions, which can be removed.

(d) A complete system of canals in the lower delta of sufficient size, and provided with tidal locks, to permit shallow steamers to circulate freely between the Menam and the rivers on each side of it.

The last two projects would render available for agricultural and industrial occupations a very large floating population of Siamese and Chinese, now entirely occupied in transport and petty trading. They are not producers in any sense of the word; and as they move slowly about, bartering small cargoes of imported goods for rice, tobacco, and the country products, they secure high profits, and limit trade. Within the last two years flotillas of small steamers have been placed on the river, but they are too small to affect the trade. In Burma, steamers have superseded the boat traffic, with excellent results.

II. *Improvements in Bangkok.*—(a) *Water-works.*—Projects have been got out for supplying Bangkok with pure water, drawn from the river 25 miles above the city, where it is free from tidal influence. At present rain-water is caught and stored for use in the dry months—December to May. The river and the city canals, which are infected with sewage, supply the bulk of the population now. The Government is favourably considering this project, which is urgently required.

(b) *Roads in Bangkok.*—Formerly, Bangkok was entirely without roads, the houses lining the river and canals, with a large floating population in house-boats. These last have much diminished in numbers, though they form a striking feature in approaching the city, and the bulk of the native trade is done from them. One road, over six miles long, runs through the city, and connects it with the mills on the river bank. A tramway runs the entire length. It is only 30 feet wide, and is to be broadened. The walled city, which contains the palace, and the Government offices and the barracks, is well laid out with roads, gardens, and open spaces. But the immense population, which is variously estimated at from 300,000 to 1,000,000 persons, is concentrated in an incredibly small area, the people swarming in dwellings, mostly of a miserable type. The king is taking a personal interest in a thorough reform. His brother has been made Minister of Public Works, and with an

efficient chief engineer and staff, new roads are being laid out and constructed, good bridges built over the canals, and the fouler spots destroyed. A river embankment is in progress; and in a few years Bangkok may be as beautiful within as it looks from the river. Extensive wharves are contemplated a short way below the city in connection with the projected railways.

III.—RAILWAYS.

All these projects, however, pale in importance to the nation in comparison with the railway schemes for developing the country. Some of these have been brought forward for many years, prominent amongst which is:—

(a.) *The Railway from Maulmein to Esmok, on the Chinese Frontier.*—Captain Sprye urged this on our Government and the public some fifty years ago; and, in 1867, Captain J. M. Williams prevailed on the Government to sanction a survey of the first portion from Maulmein to the Siamese frontier. The line would pass through the State of Chiengmai. Subsequently, Mr. Hallett made a rough survey of a line from Maulmein to Chieng-Hsen, on the Mekhong. The purpose of the line was to open up through communication with Yunnan and South-West China; and only affected Siam in a minor degree. Neither the Indian nor the Siamese Government have seen sufficient advantage to their States to justify them in supporting the project. And although the British Chambers of Commerce have been passing enthusiastic encomiums upon it for fifty years, they have neither subscribed themselves nor induced anyone else to take a share in it.

(b.) *Railways from the Mekhong to the Sea* (French projects).—From Cochin China and from Tonquin various missions and explorations have been made with the view of connecting the Mekhong above the Khong rapids with the sea. It is proposed to have powerful steamers on the 800 miles of its course from Muang Lem downwards to the Khong; and through the rapids if practicable. Mr. Paul Macey has recently travelled from Hanoi over the mountains to the Mekhong, and down this river to Saigon. He proposes to connect Hanoi to Esmok by rail, with a branch to the Mekhong, probably about Luang Prabang, where it would meet the steamers. He would run another line from Annam to the Mekhong; so that, with these lines and steamers to Saigon, the whole of the trade of Yunan, the Lao States, and the Mekhong valley, would go

to French ports. Already steamers are being built to force the rapids. Unfortunately for these projects, the Siamese Government has forestalled them by others sanctioned in ignorance of them.

(c) *The Korat Railway*.—This line has long been contemplated, and is by far the most important in Siam. Several years ago Sir Thomas Tancred caused a rough survey and report on it to be made, and only last July Sir Andrew Clarke's syndicate had the same line accurately surveyed and marked out. I was deputed by the Siamese Government to examine and report on the line, and was able to testify to the excellent manner in which the survey was being done. Korat is 165 miles from Bangkok. The line passes by Ayuthia and Saraburee for 84 miles, ascends to a pass at 1,300 feet above sea level, and reaches the Korat plain at 1,000 feet on the 112th mile, with gradients of 1 in 70. It is an easy line, and can be made for £8,000 per mile. This line has already commenced, and, when completed, it will be continued for 210 miles, in a northerly direction, to Nung-khai on the Mekhong. Still another line from Korat is contemplated, about 230 miles long, passing eastward to the Mekhong through Oobone. These railways will bring the capitals of the old States of Winchang and Bassac within 400 miles of Bangkok, and tap the river at the most advantageous points for securing the whole trade of the Lao Mekhong States. If these railways are followed up by a system of feeder roads, bridges, and other improvements, it is impossible to over-estimate the value to Siam, both politically and economically. The whole of the region drained by the Mekhong, including the Korat Plain, has hitherto been inaccessible commercially. There has been no possible outlet for produce, except at costly rates for a few valuable articles, such as silk, hides, &c., on pack bullocks or by carts, which have to traverse forests and mountains without roads or bridges for hundreds of miles. The whole foreign trade of these countries, which exceed half the kingdom in area, probably does not exceed £250,000 per annum, for a population of over 3,000,000. And yet it is one of the richest countries in the world in natural resources. The Plain of Korat is 250 miles square, covered for a great part with immense forests of valuable timber and gum-bearing trees. Rice grows so abundantly, and transport is so difficult, that it becomes a worthless superfluity. Fruit trees—the orange,

cocoa-nut, areca-nut, &c.—and the mulberry flourish; and the Korat silk is famous. The people are quiet and industrious. Salt plains are found, but probably 100 million acres of good rice-land exist, with workers idling near them unable to dispose of the produce. The plain extends on both sides of the Mekhong; and where this runs through the mountains between 19° and 21° of latitude, the forests in the valleys on both sides abound with teak, which it has been hitherto impossible to bring to market. Should an outlet be provided at Nungkhai by rail, the whole of these forests can be profitably worked; and the Lao people, the Tai-Yayee, or Great Freeman, find remunerative work, and, with the exports, pay for large imports. Cheap railway transit will give the outlet to the sea their ancestors fought for, and, in a short time, from this source alone, the volume of trade through Bangkok will be doubled. Other products, such as silk, india-rubber, gum-benzoin, are found here, with numerous other articles. With reasonably rapid progress in opening these lines, the Siamese will secure all this trade for Bangkok. There is space only to mention other lines proposed.

(d) *A Railway from Ayuthia to Utaradit, Chieng Mai, and Chieng Sen*.—These have been surveyed in detail by Sir A. Clarke's engineers. It is probable that the line to Utaradit will be made; that to Chieng Mai is problematical; and that to Chieng Sen extremely unlikely, by the Siamese, or under their guarantee. Chieng Sen is at the highest point of a difficult navigation, and near the frontier. Above it, the river is full of rapids, and no produce can reach it from Siamese territory. It is not likely that a proposed branch to Luang Prabang will be made. A branch line to Raheng will be valuable, and may eventually connect with Maulmein.

(e) A concession has been given for a line of railway, 50 miles long, from Bangkok to Petriew on the Ban-Pakong River; and a continuation is proposed to run through Cambodia and ascend the Korat Plain, to reach Mekhong beyond Oobone. The Petriew line will be most valuable, and probably will soon be made. The extension will pass through country most of which is very poorly peopled, and which cannot be profitably worked, owing to the iron-bound nature of the soil; and it will be forestalled at Oobone by the Korat line.

(f) Several railways have been projected for the peninsula, and concessions applied for. One has been given for a line across the flat

country, between Bandon Bight and Kheelong Bay. Coal is said to exist on this route. Concessions have been refused to projectors from the Straits, who proposed lines to connect with Penang. The Government favour a line from Bangkok to Pechaburee, at the head of the peninsula. This should be easily made, and profitably worked. A continuation of it down the peninsula, 340 miles from Bangkok, and across the Kra Isthmus to Pakchan Harbour, would open up extremely rich mining districts on its way, and provide a new outlet for the produce of Siam. The harbour is a magnificent port, above 30 miles long, nearly two miles wide, and with over five and six fathoms of water. It has often been proposed to cut a canal across the, isthmus to shorten the passage to China. The highest point is 250 feet above sea-level. A survey was made for M. de Lesseps, who calculated the cost of making it at under £3,000,000. Four days would be saved, compared with the Straits passage. The project has been dropped, but it is not improbable that the Pakchan Harbour may yet be utilised.

(g) A line has been surveyed, and concessions given, for a railway from Chantaboon to Battambang. This promises to be easy of construction, and very profitable in opening up the best part of Siamese Cambodia to the sea.

Time will not permit to do more than allude to the mines of Siam. At several places through the country rich deposits of ore are known to exist. The peninsula has long been famous for its mines of tin and gold. The former is extensively worked by Chinese, especially in Ranoung. The gold was mined at Bankapan centuries ago, and now an English company, with large capital and efficient control and appliances, are working it. At several other places on the peninsula there are indications of gold, and concessions have been given for working them. Other concessions for gold mines have been given at Kabin, Chantakam, and Watana, on the Ban Pakong, and arrangements are being made to work these. The sapphire mines near Chantaboon and Battambang have been given to English *concessionaires*. By prudent and vigorous working there is reason to hope a fair amount of success for these undertakings. The remote parts of the kingdom are known to possess rich beds of copper ore, silver-bearing galena, gold, coal, and petroleum; but most of these can only be worked advantageously when railways are constructed.

Altogether, there is every reason to expect a prosperous future for Siam. A fair start is

being made. There is a large amount of capital lying idle in the kingdom. In the palace alone, it is officially declared, there is over £2,000,000 sterling ready for the Korat-Nungkwai Railway; and the Government is guaranteeing 5 per cent. interest on the capital required, all of which is to be exclusively Siamese. Other projects will be thrown open to the world; and the good faith, liberality, and friendship hitherto shown by the Siamese Government, not only under the present king but in the past centuries, afford grounds to hope that, if the opportunity is availed of wisely and vigorously, there will be profitable results to all parties.

DISCUSSION.

Mr. F. W. VERNEY, after expressing the pleasure it had given him to hear such an interesting paper as that which had just been read, a pleasure which he had no doubt would be shared by the Siamese *Chargé d'Affaires*, who was present, said in recent years diplomacy had taken up the subject of the economics of the different countries with which it was concerned much more than formerly, when such questions were for the most part neglected; but he hoped those days were gone for ever, and that our diplomatic agents would continue to send home commercial information, which would year by year form an exceedingly interesting history of the economical development of these countries. This great country of Siam was of much more importance than many Englishmen had any idea of, and during the next quarter of a century would be very largely developed, and England ought to take her fair share in that development. As they had heard, there was no real obstacle in the government of the country, for it had one of the most progressive sovereigns now living, and many institutions of which it might well boast. The Siamese race dated back far beyond our own era, and had gradually consolidated their national life in a manner that had stood the wear and tear of time, though they had had to undergo many severe trials. Surely, then, one might hope for a glorious future for such a country; a future to be worked out by the inhabitants themselves, without any undue interference by Europeans. That was the wish of the Siamese and of their friends, amongst whom he hoped to be reckoned. Those who had come in contact with them knew what excellent qualities they possessed, qualities which in many cases Europeans would do well to copy. Of course, like all Orientals, they were not free from defects; but he hoped that in the future the communication between the east and west would continue and increase, to the mutual advantage of both.

Sir HUGH LOW, G.C.M.G., said he could confirm, as far as his knowledge extended, everything which had

been stated. He had had the honour of administering one of the native States, to which reference had been made, for eleven or twelve years, and its development was really wonderful, and other States in the Malay peninsula were progressing equally satisfactorily. This was due almost entirely to the good understanding existing between the British and native governments. If the native governments were treated with proper consideration, a little tenderly, not forcing them on too fast, we could always rely on their loyal support. He feared that just at present other nations were taking a larger proportionate share in the benefits of the commerce which had been opened up with many States in that part of the world—China, Siam, and others he could name—as their ambassadors were instructed specially to push forward the interests of their merchants to any extent, far beyond anything our officials did; they made it a personal matter to push forward the interests of merchants and contractors; and although the trade of England had been increasing steadily, that of other European nations had increased more relatively, if not absolutely. The British Government should do everything to secure the confidence of the native princes, and his own experience of something like forty-five years was that there was no difficulty if you had proper persons, who had some consideration for native prejudices. The upper classes of natives, especially when brought up under the care of Europeans, as many were, were thoroughly honourable, loyal gentlemen. He had the honour, some years ago, of accompanying the present Sultan of Perak to England, and never met a more honourable gentleman, and he was now very successfully filling the throne of that State, which was not very large in comparison with Siam, but the people were of much the same character. He had heard nothing of the King of Siam, except as Mr. Gordon had said, that he had always shown the greatest desire to advance his country on the most liberal lines.

Mr. F. H. LANDON said he had been for some time in Siam, and lived several months at a time in the forests with the natives, whom he had found in every respect estimable. He had no doubt that works might readily be undertaken there by European capital, and would be pushed through in the most amicable manner; in fact, he never heard an angry expression from a Siamese during his whole stay. With regard to the construction of railways, the great question would be that of labour. The Chinese were the real labourers of the country, but they were not present in great numbers.

Mr. HENRY NORMAN said his own brief stay in Siam, and his travels in the Malay peninsula, did not afford him opportunity of gaining much information on the technical points of the paper, but he could confirm what Mr. Gordon had said in some other respects. He numbered amongst his friends some leading statesmen of Siam, and had conversed with

His Majesty the King of Siam, on some of the problems connected with the government and development of the country. His Royal Highness Prince Devawongse, the minister for foreign affairs, had conversed with him frequently; and nowhere could one find a statesman in whose hands the conduct of Siamese affairs could be more safely placed. He had always showed a desire to remain on perfectly friendly terms with the representatives of various nations with whom he came in contact. There were many difficulties in the case of a country which had so comparatively recently recovered from grave national disasters, and was surrounded by powerful neighbours on all sides. There was the enormous Colossus, China, on the north, the French on the one side, and our own vigorous Indian government on the other; whilst the Germans were constantly and zealously pushing forward their trade relations. Siam stood in the middle, without any great force either of army or navy; and its statesmen had little to rely upon beyond their own skill and knowledge, and the honesty and fair dealing of the countries with which they had to do. His studies and travels had led him to consider the question of Siamese politics, especially the administration of the Malay States, through which he travelled for several months, and he happened to follow directly in the footsteps of the King, who had made a complete circuit of the Malay peninsula, taking the keenest possible interest in it, and conversing with the officials of every country he met; and he spoke English quite fluently. On his way back, he met the Siamese fleet, and learned from some of the ministers what His Majesty's experience had been. No monarch could possibly have taken greater pains to find out for himself what his own people were doing, or what other people were doing. He was quite astonished to find the amount of knowledge of complicated European politics possessed by some of the Siamese ministers. No set of men could be more alive to the necessity of conducting themselves as Europeans professed to do in international relations. Siam stood just now at the parting of the ways—she was either going ahead very soon, or she would have to go back. We were sometimes suspicious of her, and she was often suspicious of us; but all that was needed was for the Siamese authorities to appreciate the fact that the only desire of the British Government for the present was to see an independent and strong kingdom of Siam. If they once did that, her progress would be as great, if not greater, than Mr. Gordon had portrayed, and our mutual relations would be all that could be desired.

Mr. HYDE CLARKE congratulated the Section on this very excellent paper. Here was a country which, from the nature of things, was very little known to us; and this was no reflection upon us, because, considering the number of countries and subjects brought forward, even in that room, for explanation and discussion, it was obviously impossi-

ble for many to make themselves informed on them all. Such really authentic and useful papers as the present were therefore all the more valuable. Here was a country almost trembling in the political balance. So far as we were concerned, it was a question whether we should assist legitimately in its development, or see it swallowed up, like the neighbouring countries, by our French neighbours, and practically lost to the commerce of the world. Comparing what took place in the French possessions with what took place in our own, it would be seen that the world had benefited much more by our possession of territory and our influence than it had gained from the French protectorate. It was a most important question whether we should share in the development and resources of the country, or allow it to pass into the hands of monopolists. He could not conclude without expressing his gratification at seeing the chair occupied on this occasion by Sir Charles Bernard, who had so distinguished himself in the government of neighbouring regions, and had done so much for their development.

The CHAIRMAN said he must tender on behalf of the meeting their most hearty thanks to Mr. Gordon for his most interesting paper. Siam was clearly a country of immense capacity, and within the next half century she might become a great and important country. The people of Siam seemed to resemble, in many respects, the Japanese, but they had this drawback—they had not a great population of 40,000,000, and were not so happily situated geographically. Japan, a sea-girt isle, was always independent; Siam lay between three great nations, two of which were more or less aggressive western empires, and she therefore had to be very careful. He had had the honour of serving in a British dependency, next door to Siam, for several years, and, naturally, had much communication with her. He could say that the Siamese Government always gave the authorities in Burma the utmost support in maintaining peace, putting down crime, and promoting trade. One of the last things they did was to take a part, and an extensive part, in carrying a telegraph line overland from Taroy to Bangkok, which unfortunately was not very successful. As Mr. Gordon had said, though the form of government was absolute, both emperor and government were really most liberal minded. What they had heard of the sovereign going about inquiring of his own people and foreigners into the grievances that existed, and the best way of remedying them, was an excellent testimony to his character and mode of administration. They might hope that railways would be extended, and that trade would increase, for whatever country provided the railways, if protective duties were not imposed, they might be quite sure that British commerce would find its way there, and occupy the principal part of the field. It must be remembered that Siam was not, at present, very rich. The emperor had a

certain amount of treasure which he was very wisely going to spend on railways; but they could not wish him to follow the example of some of the South American republics, who went ahead making railways which the country could neither pay for nor support. When the bar at the mouth of the Bangkok river was cleared away, or the channel deepened, and when a railway was made to tap the Mekhong, such a line would have a great future; for the railways in Burmah had, under similar circumstances, paid extremely well. He was sure all would join in the wish that the relations between the British and Indian governments and Siam would always be of the most friendly and sympathetic character.

Mr. GORDON, in reply, said the only point almost he need refer to, was the question of labour. At present, undoubtedly, that was a great difficulty. The Chinese were not so numerous as they had been led to believe, and commanded high wages, which they fairly earned, as agricultural labourers and artisans. Perhaps one of the best results of making railways would be the development of the country people into labourers. The engineers who made the surveys had to educate the people, and get them to place confidence in the system of payment. At first they were distrustful, but gradually, as they found that they were treated with good faith, they would bring their money to the engineer, and ask him to keep it safely for them, so that they might not be tempted to gamble it away or spend it foolishly. After accumulating a certain sum, they would take it home; and when they were told that by so doing they would lose their employment, they would come back, nevertheless, and wait patiently for days to be taken on again. This was slow work, but, if carried on, it would develop, as it did in Burmah. There the time came when thousands would come in seeking work, though at first it was difficult to find a man who would carry a bag for you. He hoped the same thing would take place in Siam.

Captain PFOUNDEN said he sailed a vessel under the Singapore flag some 20 years ago, and he was interested in knowing what were the position and prospects of the shipping interest.

Mr. GORDON said he had dealt with the question to some extent in the paper. He did not think ship-building would ever become an important interest, as ships could be built so well and cheaply in England and sent out, but there would be a certain development of the shipping interest.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 4, 1891; SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Cooke, William George, 35, Walbrook, E.C., and Spencer-hill, Wimbledon, Surrey.
Dagger, John Henry Josiah, Endon, Stoke-on-Trent.
Gimingham, Edward Alfred, Stamford-house, North-umberland-park, Tottenham, Middlesex.

The following candidates were balloted for, and duly elected members of the Society:—

Agius, Edward Tancred, 52, Belsize-park-gardens, N.W.
Bedford, Major-General Joseph Herbert, Avenue-house, South Norwood-park, S.E.
Brooks, Samuel, Park-corner, Redhill, Surrey.
Cotton, George, Byculla-club, Bombay.
Day, Frederick Frampton, 16, Staining-lane, E.C.
Lovibond, Valentine Locke, The Hermitage, Lillie-road, Fulham, S.W.
Sabine, Alfred, Grasmead, Underhill-road, Honor Oak, S.E.
Schlesinger, Harry Adrian, Glenhurst, Coventry-road, Ilford, Essex.

The paper read was—

MODERN FLOUR MILLING.

BY J. HARRISON CARTER.

The difficulty I have experienced in the preparation of a paper on "Modern Milling" has been to make it interesting to the general members of our Society, and, at the same time, satisfying to those specially interested in the subject, and, consequently, more or less conversant with its technicalities. I have, therefore, been obliged to intersperse my critical examination and exposition of the various details of flour manufacture with some brief explanations which will, I hope, make my paper an educational one to members who have not previously studied the manufacture treated of.

And first, it appears to me I must explain to the uninitiated what was the general system of millstone milling in use just prior to the introduction of roller milling, and inform them of some of the leading points in roller milling, in order that they may appreciate the advantages of the latter.

The wheat-cleaning plant was similar to that at present in use, with a few exceptions, but was being gradually improved. The grinding was universally done by millstones, the object being to make all the flour-containing portions of the wheat into actual flour in one operation, leaving the branny or offal portions, after being dressed, free from flour.

The millstones were usually 4 feet to 4 feet 6 inches in diameter, resembling, in quality, the small one which has been lent to me for your inspection, and similar in style of "dress," that is in the arrangements of the lands and furrows. An exhaust fan was used to draw air through the stones when at work, to keep the meal cool.

The dressing was done in the best English mills, and, practically, in all the Irish and Scotch mills, by long, slowly-revolving hexagonal reels, covered with a tightly stretched silk dressing cloth. In some English mills—generally in the southern country district—"bolting reels" were used, or "wire machines"; the former consisting of a cleverly made seamless woollen sleeve or cylinder, fastened loosely at both ends, and outside of a skeleton reel. When running at its full speed—from 150 to 200 revolutions per minute—and with the feed on, the worsted cylinder expanded, and rubbed against the outside fixed rail of close-grained hard wood, which action induced the flour to come through. When worn into holes, the cloth was darned like a stocking. Cloths made in the same form, but of flax, hemp, and silk, have been tried, but are not sufficiently durable.

I describe this machine somewhat in detail, because it is still used in some small country mills; whilst in many districts in England it has never been seen, even by millers.

"Wire machines" are slowly revolving cylinders covered with wire, and having inside a set of brushes revolving rapidly, brushing the flour through the wire cover. Circular brushes outside the cylinder slowly revolve against it, keeping the wire meshes clear. The best made of these machines are excellent examples of mechanical construction, but their action is severe on the material they are operating. The silk reels produce considerably better flour.

The offal in the stone mills was divided by a simple machine into various grades.

This is a brief description of the English mill-stone system of flour manufacture prior to the roller-mill era.

To demonstrate to you concisely, but conclusively, why the millstones give inferior results to roller-mills, I shall quote first from my first paper on milling, read before the National Association of British and Irish Millers in 1879; next, from a paper read before the Society of Engineers in 1883; and, thirdly, from another read before the Amalga-

mated Society of London Operative Millers in 1882.

1879:—"If you forget everything else I have said to you to-day, please remember this, that with your heavy millstones, with their large surface, operating by friction, you reduce the wheat in one violent, tearing, rubbing, fretting action into a mixed mass of flour, offal, and offal-flour, which can never afterwards be entirely separated the one from the other."

1883:—"It has never been conclusively proved over what surface of stone the wheat has been caused to traverse before it escapes; but it is believed to be at least three or four feet. Those of you who know what a French burr stone is—so porous, so rasping in its action, and, when made into a millstone, so flat on the surface—will understand that this ordeal of grinding, this extreme of frictional treatment over so large a surface (and a smaller surface with the flat face of a millstone is not sufficient) is enough to rasp off the bran an excessive quantity of bran flour; and so it is spoiling the flour, and spoiling the loaf."

1882:—"The shape of the corrugations of rolls, as well as the material, are more scientifically correct than millstones. If you are using a 5-break system, for instance, it amounts to little more than the wheat passing five points, as compared with the 3 or 4 feet on the millstone."

The present century is often called an "Iron Age," and iron has entered into the very midst of the milling industry. It has been the privilege of Englishmen to be leaders in many of the triumphs of iron, but in the one we are discussing to-night the laurels belong to another nation, Hungary occupying the position of honour. She had for years sent us some splendid flour; and because the quality of her best brands was not materially improved on the adoption of rollers, those of our millers who would have welcomed their failure jumped at the conclusion that they had failed, entirely overlooking the fact that arrivals from Hungary of the old splendid qualities increased rapidly in quantity with the substitution of rollers for stones; and they did not know that a larger per-centage of this good flour could be produced from the same quantity of wheat. I will explain this circumstance by the following.

At the present time the very highest priced semolina (a very small proportion), sold as such in Southern Europe, or for making into the finest macaroni, is manufactured by millstones, which completely eliminate all traces of bran from the Semolina particles, but in doing it, so greatly reduce the value of the remaining product, that millstones for this

purpose are also being gradually replaced by rollers.

Having now, with this reminiscence, given the uninitiated some opportunity of appreciating the superior merits of recent innovations, I at once gladly deal with the direct title-subject of my paper, namely, "Modern Flour Milling."

I propose referring, in such detail as the time at my disposal will admit of, to the following portions of the paper:—

- I. The buildings.
- II. Grain storage.
- III. Wheat cleaning.
- IV. The flour mill.

In the first place, the buildings must not only be suitable for the milling business, but must be designed to meet the exacting requirements of fire insurance companies, and even to anticipate precautions which they, at present, do not demand.

The engine and boiler-house must be separate from each other, and, by preference, outside the other buildings. When of necessity they must be within the mill walls, they do not add to the insurance rate if proper party walls are built, but usually interfere in some way with storage arrangements, or elevating, conveying, &c.

The wheat and manufactured products must be stored in buildings preferably separated by a space of ten feet from the mill (in order that the advantage of the lowest warehouse insurance rates may be derived), and only connected with it by a spout or a light, open gangway. When the latter is used there must be double iron doors at each end.

Only one of the buildings bordering this ten-foot way may have windows. If there is no choice but to have these storage buildings contiguous to the mill, the dividing walls must be carried through and above the roof, which preferably should be flat, and of fireproof materials, the ordinary old type of mill roof being the point from which most fires spread to the adjacent buildings. Spouting only, as a rule, is allowed through the partition wall between mill and warehouse, or mill and wheat-cleaning building; and this must be inspected and approved of by the insurance company. Any spout hole should be as near the base-mant as possible.

Communication may be by open gangways outside the mills, as in the case previously referred to, if the usual insurance requirements are complied with.

The flour-mill building should, above all things, be of ample dimensions, having five

floors, each about 12 feet high, except the top floor, which should be about double this height; at all events in that portion of it where the elevator heads are placed.

The floor should be of 3 inch planks, resting on beams or girders of ample strength, and 8 feet or 8 feet 6 inches apart from centre to centre. Above the planks a diagonal flooring of 1 inch boards should be laid, certainly for the roller and purifier floors, if not for the others. This construction is infinitely preferable to board and joist floors, if for no other advantage than that in the case of fire it resists the latter much longer, giving a better opportunity for its extinction.

The mill should be designed of sufficient strength to admit of high and wide windows between each abutment, on all sides of the building, if possible. Above and before all, there should be sufficient area to secure such an arrangement of machines as will provide ample room for the men in charge to examine and attend to all working parts, and the manufactured products of each machine, without any inconvenience or risk.

The electric light is a modern adjunct of the highest advantage to the manufacturer, and, if properly installed, diminishes the risk of fire as compared with gas. Every mill should be fitted with sprinklers, and other fire-extinguishing appliances.

Insurance companies are said to have lost heavily on flour mills; if they have, it is their own fault. They have imposed, from time to time, a higher and still higher rate, so much for this class of new machine, and so much for that, but never any tariff charge for overcrowded machines and stock; no extra charge named for uncleanness, and nothing imposed for want of light by day, and naked lights by night: and yet it is my firm opinion that more fires are attributable to these three causes than to all others put together.

I make no apology for dealing at what may appear inordinate length on this subject. It is not a question which can be settled by the factory inspector, but it materially affects the health and comfort of the operative and the balance-sheet of the master miller.

GRAIN STORAGE.

Grain is now stored, by preference, in silos, and I know of nothing that can be said against this system. It is probably of Scotch origin, high circular hoppers having long been used in that country; but it is to America we owe their scientific development.

In this country the first large installation was completed for the Liverpool Grain Storage Company. The design was well considered, and has been a very great success, though when first put to commercial test it was found by the purchasers of grain most unsatisfactory, the wheat purchased by sample coming from the silos of very unequal quality, sometimes much better—when, naturally, it was not complained of—but on other occasions very much inferior, entailing a serious loss. This irregularity was caused by the tendency of the heavier—that is, the better—portion of the wheat to separate itself from the inferior, or lighter, portion, whilst being drawn from the silo, the heavier displacing the lighter and escaping first, the consequence of which can be easily understood.

Sprague's and Henderson's methods for overcoming this are somewhat similar; the former I can describe as consisting of drawing off the wheat from the top by means of some wooden slotted trunks fixed to the sides of the bin, at the same time that it is drawn in the ordinary way through a spout at the bottom. This results in a perfectly uniform sample. It was adopted by the Grain Storage Company, and now from it and all other silo granaries wheat can be relied upon as being true to sample.

Only one serious accident has occurred in England after the completion of silos. The weight they carry being frequently enormous, great care has to be exercised in their design and construction.

The cost of storing in silos is very small, and I would strongly recommend the system to millers who freely use English wheats. The conveying and elevating arrangement for filling and emptying is seldom required continuously for this purpose; and it can therefore be employed without any great personal attention being required, in frequently drawing out of one silo and emptying into another any wheats which may be at all out of condition, the moving, especially if, as there should be, there is an aspirator under the main elevator, greatly improving the condition of the wheat.

For procuring the necessary mixtures of wheat for grinding, various automatic mixers have been used, most of them being measuring appliances. I do not consider them sufficiently accurate, and much prefer automatic weighers.

The usual system of drawing off the mixture for wheat-cleaning is to fill these weighers from three, four, five, or more silos, elevating each kind direct into the same number of smaller silos

situated close together, and called the mixing silos. The automatic machine under each of these smaller silos takes out of each the required proportion, and it is then consigned to the wheat-cleaning bins. But this use of the nest of mixing silos necessitates double elevating and conveying.

In some extensive silos which I have just designed, a method has been adopted dispensing with the mixing silos and substituting the use of weighers, made portable for placing under any of the main silos, in number corresponding with the varieties of wheat forming the mixture at any particular time.

The system of automatic weighers which has commended itself to me, secures a simultaneous discharge of all the weighers, each with its varying proportion of wheat, thus securing an equal blending of the mixture.

WHEAT CLEANING.

This is a very important part of the manufacturing portion of the process, and one which is deservedly receiving an increased amount of attention. Some of the necessity for an elaborate plant is caused by careless husbandry in foreign countries, and much more from roguery, the chief offenders being India, Egypt, the Argentine, and Russia, the ratio of offence being, I think, chargeable in the order named. It is a cause of pride to Englishmen to be able to state that wheat is sent to us by English colonists and our American cousins in a much cleaner and more trustworthy condition; but it is with deep regret that I feel obliged to strongly condemn the action of the London Corn Trade Association, at a Conference on Indian Wheat Impurities held in May, 1889. It was convened at the India-office by Lord North, and presided over by him. His lordship, in advocating the importation of clean wheats, said:—"Some parcels had more than the allowable 5 per cent of dirt, and that our annual importation of dirt in Indian wheat reached the astounding quantity of 3,000,000 cwts." Corn Trade Associations from other Ports, Chambers of Commerce, the Millers' National Association, independent millers by the hundred, testified in writing, or by their presence, to the fault in the present system, but it remained virtually for the London Corn Trade Association to uphold it, doing so in a long report, in which I have failed to find one single sentence showing a disposition to co-operate for a reformation.

I have been informed that Messrs. Ralli Bros. ship seven-tenths of the Indian wheat; and I believe they are members of the London Corn Trade Association. Their representative at the Conference, Mr. Manuell, said, "When cleaner wheats are offered by us, we do not get the value." I appeal to every miller present—Is not this an absurdity? Does not a miller, every time he makes ever so small a purchase, judge by his practised eye, and hand, and sense of smell, what the sample is worth, and bid accordingly? Why, therefore, should he make an exception in the case of Indian wheat? Granted for a moment that he does make an exception, why is it? Simply, I believe, because of his helplessness under the "Fair average quality" shipping contract, by which stones and dirt are actually admitted up to 5 per cent.

This has an important bearing on competitive modern milling, which our Society has recognised in papers read by Mr. John Macdougall, which attracted a vast amount of attention at the time, but which have, so far, resulted in but very slight improvement. The importance of this matter has induced me to make these remarks on the subject.

In Indian, as I have said, and some other wheat there is a great quantity of stone and dirt, which is a source of great trouble, necessitating a complete preliminary wheat-cleaning plant, composed of the following machines.

First, a warehouse separator, of which several designs are made. It consists of a set of sieves of perforated iron or steel of various meshes. Extraneous matter, also beans, maize, &c., pass over the top coarse sieve, the out-siftings passing to another sieve of finer mesh, through which fine dust, sand, and seeds fall, the over-tails being the cleaned wheat, which passes through an air-current produced by a fan forming part of the machine, and which exhausts a large quantity of light dust and chaff, &c., &c. The wheat then falls to the second machine, which is a grader or sizer, dividing it into three, four, or more sizes. Some engineers use sifters for graders, others, cylindrical machines.

Each size of wheat passes into a separate cylinder of thick metal, having drilled or indented cavities close together.

What are known as "Victoria" cylinders have the indentations on the outside. The purpose for which these machines are used is to separate from the wheat, the oats, barley, cockle, and other seeds, stones, dirt-balls, &c.,

and generally all bodies of different shape from wheat grains. They are usually arranged in two rows, one above the other, the top row extracting oats, barley, and all grains larger than wheat; the bottom row removing cockle and all round seeds smaller than wheat. The indentations in the top row lift the wheat, depositing it into a trough suspended from the axis of the cylinder, the oat and barley escaping at the end. With the lower cylinders the operation is exactly reversed, the indentations carrying up the cockle and allowing the wheat to escape at the end. Each cylinder is drilled to suit the mesh of that part of the grader from which it receives its supply.

The next part of the process is that of washing. Washing has long been considerably practised in France, especially in the south, where they wash all the wheats, whether native or foreign. To a lesser extent it has been practised in England; and though with us there is still a lingering prejudice against it, our leading firms are gradually adopting it as a recognized portion of the wheat-cleaning department, most of them, very rightly, using washing machines for hard wheat, even if it does not contain any perceptible amount of dirt.

An ordinary type of washer consists of a tank partly filled with water, which is being constantly changed. The wheat is delivered on to the water when the stones and heavy particles sink to a receptacle in the tank, and the wheat is carried on by the water to an inclined worm, partly in and partly out of the water. That part of the worm in the water is enclosed in a wire cylinder, whilst the other part revolves in an open trough. The turning of the worm breaks up the dirt balls, &c., which are separated from the wheat by the water, and settle in the tank. The wheat, as it is carried up by the worm, is partially separated from the water in that portion of the worm outside the tank, and is delivered at the upper end of worm into a whizzer, or centrifugal. Various illustrations of machines are shown by diagrams on the wall; but there are other good machines not illustrated.

From the centrifugal machine the wheat passes into sacks, in which it remains for periods of from 24 to 36 hours, during which time some of the moisture passes away by evaporation, and some by absorption into the kernel of the wheat.

It is important that there should be no breaking or grinding action by the machines which precede the washer, or by the washer

itself, or water permeates unduly to the flour portion of the berry, and is injurious to it: at the same time, there must be sufficient action to break the dirt balls, but without abrading the bran.

Wheat-washing is an operation which will repay further experiments. I am favoured with letters from French millers, strongly recommending its use for all wheats.

We have now left the washed wheat in sacks, and still very humid. In the case of very hard wheats, the absorption of water toughens them, and enables the break rolls to produce larger bran, but it is a question whether this is the true method of toughening. Even the driest of wheat contains a certain per-centage of moisture, and bakers do not wish to purchase water at 2d. per pound whilst they can procure it almost for nothing.

I have never tested, in actual work, the method of wheat-heating, originated, I believe, in America; and am not aware whether the system is or is not extensively used in that country now. It was tried by a few British millers, but never largely persisted in.

The effect of heating is to draw the moisture from the flour, or kernel portion of the berry, to the skin or bran; and this should, apparently, benefit both. The heater, when used, is placed to precede the first break roll.

Instead of leaving the washed wheat in sacks, as previously referred to, it is now frequently taken at once into kilns.

There are several kilns in the market, some of which are illustrated on the walls. It is my firm opinion that those will ultimately be found the best which are large or roomy; that is, which, instead of holding a small quantity of wheat, and drying it under a high temperature in a short time, will hold a large quantity, drying it under a lower temperature in a longer time.

In my first paper on milling, read before the National Association of British and Irish Millers, in 1879, I expressed myself as follows:—

“Our native wheats I would strongly recommend being dried, when in the condition in which they came to the mills this year. Drying does not injure the grain in any way; and if it is wheat which has been properly matured, and merely become wet after cutting, it gives back a great part of its intrinsic excellence. If the wheat is not matured, as in the case with most of this year's crop, drying does, to a certain extent, mature it. Old native wheat is more valuable than new, simply because it has in the stack

been subject to a slight warmth or sweating—has, in fact, been drying.

“Wheat, on the ordinary kilns, is subject to a heat of from 70 to 100 degrees Fahrenheit. The waste varies from $2\frac{1}{2}$ to $7\frac{1}{2}$ per cent.; but this year, from 5 per cent. to 10 per cent.; and, in the experience of some Irish millers, from 10 per cent. to 15 per cent.

“Do not think that kilns are only useful for drying native wheat. They can be used with advantage for drying washed Egyptian wheat, and, by a slight modification, for fumigating heated wheats. If a cargo of the latter be only slightly heated, the smell may be entirely removed by putting a certain quantity of sulphur and sal ammoniac on a clear fire, and allowing the fumes to pass through the wheat.”

Applying the advice I gave in 1879 to the present time, I should say wash all your foreign wheat which would not be injured by the water.

Experts will be thinking that I have overlooked the practice of conditioning hard and soft wheats by mixing them. This is a very easy system to adopt, but is imperfect.

Years ago I advocated the separate rolling and dressing of wheats of diverse conditions, and I have not changed my opinion, because it is impossible to alter the natural peculiarities of various wheats sufficiently to make the grinding, and more especially the dressing process, uniformly suitable for both. This system necessitates mixing the flour.

Having completed the preliminary cleaning of wheat containing large quantities of dirt and stones, we come now to the ordinary mixture of wheat. This is drawn off in the required proportion from the various silos, and passes into the final wheat-cleaning plant.

I should mention that this mixture is partially made up of the wheat which has been through the preliminary wheat-cleaning plant. This is an elaborate process, and rightly so; at the present time it would pay for greater elaboration. For example, the roller mills, scalpers, purifiers, and dressing machines in a mill of large capacity, are of the same size, speaking generally, as in a plant of medium capacity; whereas in a wheat-cleaning plant of large capacity, the machines, excepting only the indented cylinders, are usually of much larger size individually, but not proportionally so numerous as they should be. I believe the same advantage would be derived from additional sifters, separators, and scourers, as certainly is obtained by the additional indented cylinders; that is, a more perfect operation would be performed.

Again, it is almost a universal practice to run the roller plant night and day (though

there is an extra insurance charge for night work); but it is almost as universal a practice to run the wheat-cleaning plant during the daytime only. Millers would undoubtedly benefit by running the latter continuously.

The *modus operandi* of a wheat-cleaning plant might be as follows:—

The wheat should first be passed through an automatic weigher; then over a magnetic separator; then to a grain separator, consisting of sieves and air currents, which extract light and inferior grains, chaff, seeds, sand, &c., which escape the warehouse separator. From thence the wheat passes on to grading machines to be graded for the oat, barley, rye, and cockle cylinders, described in the preliminary plant. This operation is succeeded by a wheat-scourer, with a fan and exhaust trunks attached, by which means weevil-eaten and inferior grains which have broken up or opened out by the beaters, or branny particles or chaff released from the wheat berries, are all separated from the wheat. A second scourer and aspirator is then used; then the only remaining operation is that of polishing through brush machines, and weighing through another automatic weigher to ascertain what has been lost by cleaning.

THE ROLLER MILL.

I now come to what is looked upon as the flour mill proper. In olden days it was a combined warehouse, or mill. In the present day of scientific milling, a rule which should always be, and is observed in a few cases, is that there should be no sack in the mill, and no machine in the warehouse.

The first great principle I would lay down for successful flour milling is exactness, cleanliness and neatness. It is not only good of itself, but the training of young master and operative millers in the observance of cleanliness and order, means the cultivation of the habits of exactness of all things which will conduce to making them successful millers. The cleanest mills, as a rule, belong to millers who make the best flour. A carelessly kept mill is a bad one for a baker to purchase from; bad for an insurance company to insure; and, generally, an unprofitable one to the owner.

The usual depreciation for the wear and tear of flour-mill machinery should be considerably increased in the case of mills where cleanliness and general attention to the machines are not carried out.

The processes in a ordinary roller mill plant are:—

- 1st. The break roller process.
- 2nd. Scalping.
- 3rd. Purifying (which, however, is preceded by some dressing and grading).
- 4th. The smooth roller plant.
- 5th. The dressing process.

BREAK ROLLERS.

A French miller, after a recent tour of English roller mill inspection, told me that he thought our weak point was the overcrowding of our machines. And there is much truth in this statement.

Recent controversy in the department under discussion has foreshadowed advantages to be gained by decreasing the number of breaks. My first mill was erected on the four break system; a fifth break was then added with apparent advantage, and then a sixth with like results. The modern four break advocate will acknowledge this, but will no doubt say he also would have added the two machines, but divided their work between the second third, and fourth breaks. But I always found that with only four breaks, the steps of reduction had to be so decided that the thick portion of the roller corrugation had to enter the wheat deeply, causing an undue amount of break flour to be made; and this I found in a less degree with five breaks. I erected two mills with seven breaks, but found no advantage over six. The estimated gain in four breaks, if made at all, certainly accrues from lessening the number of elevatings, scalplings, and spoutings, and the consequent reduction of the general pulverisation of the material, while branny particles are present. It is probable that the conversion of the first break roller into a machine which is to do work nearly approximating to the old second break, may be sanctioned. In our English early days of roller milling, the miller at once appreciated the advantages, as he thought, of the first break process, and frequently added the machine to precede his millstones, and immediately thought he saw a great improvement of his flour. But how could there be a *great* improvement, when all he had succeeded in doing was removing, say, $\frac{1}{2}$ per cent. of inferior flour?

Replying, in 1883, to an able millstone advocate (since become an ardent roller convert, but, at the time, only shaken in his faith to the extent of the first break), I said, "My opinion is, that this first break question, which is receiving so much attention, is very much exaggerated by those who have looked at the

first break flour. A great part of the inferior coloured flour is made in the last break; but every $\frac{1}{2}$ per cent. of low grade flour which can be separated from the good, should be so separated."

The constructive features of roller mills would repay careful examination; but as other departments are, in my opinion, more important, and time is pressing, I pass them by, hoping, however, that they will be discussed by any person who desires to do so.

SCALPING.

This is, of itself, an important part of the manufacture, frequently overlooked in the early days because of the ease with which the machines do their work, and the comparatively little attention they require. The great object to be kept in view is to procure flour of the best obtainable quality; to make as little of it as possible, and to send none of it to the succeeding break roller mill.

The machines for effecting this object at present may be said to be of the three following classes:—

Reels of various designs, including inter-elevator reels.

Sifters, having a rotary or reciprocating motion; and

Spout scalpers, which take the form of an inclined frame covered with perforated metal on the bottom. The amount of inclination in the spout scalper varies with each succeeding break, and is such that the natural angle of repose of the material is only slightly exceeded, thus causing a very gentle action.

Scalpers are rarely used for the last reduction, most firms adopting the centrifugal dressing machine. But I now want you to consider with me the best machine for scalping all the previous breaks.

The old-shape hexagonal reel, with deep rails acting as lifters, carrying much of the broken wheat high up in the cylinders, and dropping it on to the wire, was very objectionable; whereas a cylindrical reel of the same size was so gentle in its action as to cause floury overtails. I, therefore, from the first, used hexagonal reels, with rails shaped to fill up the angles but not to act as lifters. It would have been better had I made cylindrical reels of large dimensions.

Inter-elevators claim to have a very gentle action, and to occupy but a small space; but I cannot speak of them from experience.

Rotary sifter scalpers are used by several of the principal engineers; and sifter scalpers

with the ordinary reciprocating action are used in some mills. In my opinion rotary sifter scalpels offer no advantage over reels such as those I describe, the agitation on rotaries being greater than on cylindrical reels. Anyone doubting this should watch the two machines at work. In both cases, of course, the heavy particles gravitate to the cover; but whilst in the cylindrical reel the product can scarcely be seen to move, except that it flows gently on towards the tail; in the rotary there is a very considerable agitation of product against itself and against the sides of the sifter.

The "spout" scalpel, inasmuch as it is not, I believe, used after the fourth break, unless with the addition of a "jumper" motion, evidently is a machine of very gentle action.

As a means of preventing an excess of break flour of inferior quality, nothing has been so beneficial as the substitution of perforated metal for wire as the sifting medium.

To send no flour to the succeeding roller mill requires a certain amount of agitation: to make the least per-centage of flour suggests the gentlest admissible treatment. To obtain good flour demands quick separation from contact with branny particles, and no scouring action.

Millers should watch this portion of the process more closely than they do. Very few of them know what per-centage of break-flour they produce; or, in other words, how much of the semolina they make into flour before purifying.

PURIFYING.

In primitive times, this process consisted of a few dexterous turns of a hand sieve by the miller, and then of skimming off, by the hand, the inferior products which had collected above the good semolina at the bottom of the sieve.

Purifying has probably required and received more attention, and been more experimented with, than any other department of milling. Even smooth rolls will rub some inferior flour off branny particles, therefore it is important to have the semolina and middlings as pure as possible before each rolling.

I purpose describing first, four representative machines, of which I have been favoured with illustrations, and then revert to a general examination of purifying. Naming the machines in order of seniority, they are the "Reform," "Victoria," "Koh-i-Nor," and "Omega."

The "Reform."—The features which strike me as being the best in the "Reform" are the set of cross troughs suspended above the sieve, extending from head to tail of the latter, and a woollen dust collector and air distributor. The troughs are an admirable device. The air, as it goes upward towards the exhaust fan, laden with all inferior particles sufficiently light, passes between the troughs, and then suddenly expands, depositing the heavier particles in the troughs, from whence they escape by means of longitudinal troughs at each side of the sifter.

The fan on this machine has sufficient power to draw up to these troughs material which otherwise might descend to the sieve (as explained in my later remarks), and mix once more with the stock, and, by overcrowding or accident, escape through the sieve with the pure middlings. I am greatly in favour of any system which will prevent the latter occurrence.

The "Victoria."—The "Victoria" is decidedly a new departure, inasmuch as it dispenses with the dust room. The fan can be seen slowly revolving and blowing the air into the open mill. Any light, flocculent, or dusty matter which might be in the middlings is deposited within the case of the machine. Another novel feature, first introduced into this machine, is the placing of a set of nozzle trays almost close to the silk, so that with a small quantity of air an intensified current may be produced in the nozzles themselves, sufficient to raise the impurities.

The inventor has so arranged the nozzles that no particles can traverse the silk without passing under a sufficient number of them to effect complete purification.

The proximity of the nozzles to the silk is an assurance that this intensified current is actually operating through the silk meshes. Another advantage (referred to in my general remarks on purifying) in the proximity of the nozzles to the sieve is that no sooner is a branny particle lifted from the silk than it is safely deposited in the shelter of the nozzle tray.

The "Koh-i-nor."—The "Koh-i-nor" is also of novel construction, very different in appearance to any other machine. It consists of a tapered sieve, becoming narrower at the tail end. Like the "Victoria," its fan blows direct into the mill, and yet without blowing dust into it, all the light matter remaining in the machine. The claim made for the tapered sieve is that as the middlings or semolina continually decrease in quantity as they flow

onward towards the tail, the narrowing of the silk insures a continuation of the same thickness of feed as at the head of the machine, thus securing the opportunity for the gravitation towards the silk of the heavier particles, the lighter floating on the top. As the sieve narrows, the platforms (as they are called) on each side widen, leaving ample room for the settlement of the material drawn off the sieve. I have not worked this machine practically.

The "Omega."—This purifier has crossed troughs above the silk, somewhat after the "Reform" style, but its fan blows straight into the mill floor, like the two last machines. The troughs are gradually tapered down to a sharp edge close to the silk, so that almost immediately after the particle is raised off the silk by the air, it gets into a gradually increasing current, which ensures its being lifted into the troughs. The latter, I should say, do not vibrate with the silk, but are stationary, and swept out continuously by an automatic brush.

Another distinct feature of this machine is a bend upwards toward the tail end. The effect of this is to check the flow of the middlings (which, of course, ere reaching it, have become less in quantity than at the head), ensuring a good covering of stock on the sieve until the tail is reached, allowing, as in the case of the "Koh-i-Nor," of the gravity operation coming into action.

The overtails of the machine pass through a gravity purifier, which catches any light particles that may have escaped the exhaust on the sieve.

In making a few general remarks on purifying, I would say that good purification can be effected in various ways. I have seen striking illustrations of this in southern Europe, semolina and middlings of the most perfect description are procured from purifiers which, apparently, are most unscientifically and imperfectly constructed. In some of them the only attempts at an air-current are applied by bellows puffing little jets of air under the sieve, and at some considerable distance apart. In others a fan is used, also blowing air through the sieve from below, but with no attempt to make the air-current equal throughout the entire length.

The principal care of the miller is to have a *sufficiently thick feed on the sieve*. The silk at the head is fine, so that very little material escapes through it, and in this way time is gained for gravitation to take place, the purest middlings getting to the bottom, the inferior or larger particles floating at the top; in fact,

the purification is almost entirely achieved by gravitation. This is a point we should not lose sight of, and is to a certain extent provided for in the "Koh-i-Nor" and "Omega" machines.

When I made purifiers, I arranged a "cut-off" from the tail sheet to the head of the machine, which effected this purpose.

I have often heard millers say, "Purify semolina and middlings thoroughly in the early stages, and the stock will then be pure throughout." This is a fallacy. Purifying should follow each smooth roll reduction. Of course, purify as well as possible at all stages; and if the break roller mills would make only two products—pure middlings and pure offal—it would be an easy matter; but the flour-producing particles adhere firmly to the branny; and, down to the last smooth roll reduction, a separation is being made by the rolls, but a difficult problem left for the purifier. In fact, each purifier has to treat a product made up of a certain portion of pure middlings, a middle quality, *i.e.*, a product consisting of middlings adhering to offal, and finished or pure offal. The first, with care, comes through the silk easily; the third should be taken away without much difficulty; but it is the medium, of most diverse shapes and gravity, which, going, by overcrowding or accident, partly either with the first or third, gives imperfect results.

Millers are usually careful to have the offal clean; so the best middlings are not; and I want to point out why. Semolina and middlings, of too wide a range of sizes, are fed on to each purifier, which is a great mistake, and, while this is persisted in, purification will not be perfect. Supposing even the various sized particles were of the same gravity, a similar air current for all sizes would not answer, a proportionately stronger draught being required for the larger than for the small particles; and when it is considered that the particles are of a very varying gravity, the difficulty is increased. To put it briefly, the products to be purified should be graded into far more sizes than at present, by grading machines placed on the floor above the purifiers. The result would then be pure middlings through the silk; medium quality, as overtails, for the next smooth roll reduction; and offal in the troughs. At present, with the products of divers sizes, the purifier is clothed as a grader. Each varying sheet of silk demands a varying air current, the latter increasing with each silk towards the tail; and then what

happens is, that the medium quality which overtails from the head sheets, will, some of it, be taken up into the troughs, when it comes to be subjected to the stronger draught lower down the sieve; and it will mix with some inferior products from these lower sheets, although the air current on the latter is frequently less than it should be for the heavy middlings, which have to be treated on its coarser meshes.

Another cause of imperfect results is that small impure particles, in a certain proportion, are accidentally pushed through the coarse silk, in spite of the air currents which, towards the end, become partially naked.

The overtails from most purifiers I find contain some pure offal; and as this offal has come the whole length of the silk, it is clear that, as I said before, a certain proportion has probably passed through.

It is undeniable that it is a practice to re-purify outsiftings, or overtails, or the troughs or tray products. The practice varies in different mills, and, usually, these products from several purifiers are sent on to one, making still a wider range of sizes, and imposing a more impossible demand on the purifiers.

It would require a separate paper to discuss this matter in detail; but if such a system as I have sketched—of grading machines preceding the purifiers—were carried out in a new mill, it would not add inordinately to the cost, and would insure a more perfect result.

The advantage of the troughs and trays being close to the silk, is very great. In watching an old purifier with the valves high above the silk, particles can be constantly seen starting upwards towards the fan; when, suddenly they fall on to the silk again, and, of course, sometimes through it. This is probably caused by a branny piece having a particle of good middlings at one end or side, which, after a time, exercises the power of its weight by an arrow-head kind of action, and brings it down, sometimes through the silk with the best middlings. In the new machines, these pieces are taken almost instantly into their place of rest in the troughs or nozzle trays.

Until grading is adopted, as I suggest, it seems to me that the modern purifier requires another chamber, which would give the following results, and obviate re-purifying:—

A first quality, as pure outsiftings.

A second quality, as good overtails.

A third quality in the first troughs, nozzle trays, or platforms.

Offals, in a second range of these appliances, and

Stive in the usual chamber.

I mention these matters to prepare millers for the fact that new mills must be more and more elaborate, and the machines still more scientifically made and handled.

The advantages of the present purifiers, from an insurance point of view, are incalculable.

Explosions in mills, as far as I have been able to ascertain, never occur in air trunks leading to rooms. Any spark from a naked lamp, or other cause, does not produce an explosion until reaching the great dust cloud in the stive-room. Insurance companies fear that the purifier room, with the fans blowing direct into it, will become a huge dust room; but the miller would not allow that. If flour were coming on to the purifiers, and the fans were blowing it into the old stive-room, no one would see it, and an explosion might take place. But the moment any flour appeared in the purifier floor, the men in charge would see immediately that something was wrong in the dressing department, and the irregularity would be rectified at once, and an explosion prevented.

Gentlemen from insurance offices, who have recently consulted me about these matters, have had my opinion, as above expressed, plainly pointed out to them.

SMOOTH ROLLER PROCESS.

I must pass over this part of the process, owing to want of time, with a very few words. Great responsibility rests on the maker, that he shall construct absolutely true rolls, running in absolutely true bearings, which latter should be so accurately adjusted that the rolls cannot rattle in the bearings, or, as it were, hammer against the middlings being rolled. When this occurs, the ground product is a mixture of flakes and granular meal, neither of which will make flour properly.

FLOUR DRESSING.

The proportion of flour produced from good wheat is from 70 to 73 per cent. If you will examine even the finest offals under a magnifying glass, you will see that the particles are larger than the flour particles, "As fine as flour," like "As jolly as a miller," is a recognised proverb. It is, therefore, evident that the finer the meshes of the dressing

cloth through which the flour can be induced to pass, the smaller the per-centage of offal which would escape with it; in other words, the purer will be the flour.

I have given an indication of the various flour-dressing machines in an earlier part of my paper, and time does not admit of my going into every detail of their construction. Of course, silk cloth is the dressing medium in all of them, and reels or centrifugals are the most usual machines. In both these types, the material being dressed is impelled in the latter case, and falls in the former against the silk obliquely; and owing to this oblique direction of the flight of the particles towards the silk cover, they would not pass freely through unless the silk meshes were considerably coarser than would have sufficed if the flour particles had been impelled in a *direct line towards them*. This is no new theory. Professor Kick, with whom I passed an instructive day at the University of Prague several years ago, and to whom I am indebted for some kind communications, gives it as his opinion that no alteration in the form of centrifugal beaters will effect a cure. They can never, he says, "effect an improvement."

A recently patented dressing machine, called the "Impact," has been introduced, which, so far as I have been able to see from work being done, certainly does approximate to the desired end.

The effects in the manufacture of pure flour, which can be produced by securing a workable result from a dressing machine that impels the flour in a direct line towards the spaces in the silk cloth, instead of obliquely against the strands, will be most valuable and far reaching. In some districts, coarsely dressed flour is preferred; but it is difficult to procure it pure, especially in the lower grades. A machine of the description foreshadowed would make it possible to obtain an equally granular flour through silks, probably three or four numbers finer than those used on the present machines.

SUMMING UP.

I have brought forward two incidental, but very important matters, namely, the insurance of mills, and the importation of dirty foreign wheat. The technical points I have submitted, and which I hope will be discussed, are principally—

Wheat washing and drying.

Scalping.

Purifying.

Flour dressing.

In conclusion, I may express my delight at the position of British milling now, as compared with the time prior to the introduction of the roller system. Then, all was misgiving and distrust. Now, millers—both employers and *employés*—have a knowledge of the most advanced, namely, English milling. They study the science of it thoroughly; they work out the practice of it persistently; and are determined that British milling shall equal, if not surpass, the milling of any other nation in the world.

To illustrate the ideas I have just placed before you of a good building, but circumscribed a little owing to the limits of space, I have brought with me plans of a very large mill which I have recently designed for Messrs. James Tucker, Limited, of Cardiff. It contains every requirement of manufacture, and also includes workmen's dining, smoking, and reading rooms, hot and cold plunge baths, and lavatories. The mill throughout is well ventilated, and all the windows can be easily cleaned outside as well as in; and every room will be heated in cold weather, this latter arrangement not only being a comfort to the men, but of great assistance towards good and uniform milling.

I am indebted for the following to the firms stated below:—

DRAWINGS.

W. R. Dell & Son, drawing of "Victoria" brush machine.

Grain Storage Company, Liverpool, plans of silos.

Higginbottom & Co., Liverpool, drawings of "Victoria" purifier.

Hind & Lund, Atlas Works, Preston, drawing of 4-roller mill.

Thomas Robinson & Son, Limited, of Rochdale, drawings of Parkinson's "Koh-i-Nor" purifier, and Mallinson's wheat-drying kiln.

Institution of Mechanical Engineers, drawings of Simon's "Reform" purifier, lent by kind permission of the Council.

E. R. and F. Turner, Ipswich and London, drawing of centrifugal dressing machine.

Messrs. Van Gelder & Co., Liverpool, drawing of wheat-washing machine and "tornado" dust catcher.

Messrs. James Walworth & Co., Bradford, drawing of wheat washer and drying kiln.

Drawings of Carter's 4-roller mill, "Carter and Zimmer" sorters, and of James Tucker's (Limited) Flour Mills, Cardiff.

MODELS AND SAMPLES.

Blackmore & Co., Wandsworth, seamless bolting cloth.

Bryan Corcoran, junr., London, model of millstone in frame, with driving gear; samples of wire for dressing machines; silk dressing cloth; and some specimen pieces of millstone.

W. E. Dell & Son, London, fluted roll.

Higginbottom & Co., Liverpool, model of nozzles.

Mons. Lautier, of Marseilles, samples of middlings purified by old-fashioned purifiers.

DISCUSSION.

Mr. G. CHITTY (Dover) said he had listened with great interest to the paper, the more so as his mill was run mainly with machinery furnished by Mr. Carter, which had proved so satisfactory that hardly any alterations had been needed since the engineers left.

Mr. STRINGER (Manchester) said he much admired the tact and courtesy with which Mr. Carter had dealt with the machines of rival manufacturers. He could thoroughly endorse one point on which stress had been laid, viz., the difficulties of fire insurance. The firm to which he belonged had paid great attention to this matter, and, within the last six months, had laid three papers before insurance offices with a view of getting them to change their irrational tariff to some system which would discourage fires in flour mills. The present tariff penalised things which entailed no risk at all, whilst, if a miller literally followed the directions of the tariff offices, he would be more liable to fires than if he disregarded them altogether. The rates ought to be placed on the risk of fire, but they were placed on machinery, putting the engineer in this dilemma, that if he followed the tariff, he made the mill very liable to fire; but if he neglected the rules and followed his common sense, the tariff offices would not insure the mill. The question of purification was very important, and the different types and features of purifiers had been well described. Mr. Carter had truly said that the difficulty lay in separating the semi-good stuff, and in this respect there was a distinct difference in different machines. The system on which the "Reform" worked was to lift the material and separate the medium, and put it into the troughs. To do this a sufficiently strong current of air was required, but the shape of the troughs had nothing to do with it. Long and protracted experiments had shown that it was impossible to get a sufficient current to lift the impurities, and at the same time blow the air directly into the mill free from dust. You must either lift only the offal and let the semi-light material fall down to come

through the tails, or through dead sheets, or flow over the tail with the good of the same size, or lift it in the purifiers. In the old "Reform" only sufficient draught to lift the pollards was employed, floating the other along, and only the good stuff went through. In the latter machines the tails were equally pure with that which went through the silk. With regard to drying wheat, his opinion was that you should have as thin a layer as possible, and dry it as slowly or as quickly as you liked without injuring the berry. If you had a layer of wheat several inches thick, he always found the under layer would part with its moisture to that which lay above it, but if you had only one, in the moisture came away with less trouble, less heat, and more effectually.

Mr. W. RAWLINGS said one would imagine from the last speaker's remarks that fire offices desired flour mills to be inflammable. The fact was that no sooner was a machine legislated for by the offices, and a certain charge made for it, than a similar one practically, but under another name, was introduced, which they were told was not the one rated and ought not to be charged for. He should like to know Mr. Carter's opinion as to the comparative inflammability of dust coming from millstones and from the roller process. He had practically condemned the rotary sifters, but he should like to hear his opinion whether the danger of bran dusters was not minimised by the rotatory sifter if brushes were not used. Some offices thought such a machine should be charged for.

Mr. H. J. DAVIS thought the roller system of milling was introduced because now-a-days every one wanted everything pure, and, with the millstones, it was impossible to get the flour out without getting some of the bran as well. The bran was separated by friction, and by the friction some of the branny particles were rubbed off and incorporated with the flour. So it was with the roller miller, if you made flour in the first breaks, it was impossible to avoid some bran being mixed with it. The object, therefore, was to make by the first process, not flour, but middlings and semolina, which were purified from the branny particles before going to the smooth rolls to be ground into flour. The insurance question had always been a sore point with engineers and millers, mainly because the insurance offices did not know what was really dangerous. It always seemed to him that they were anxious to get something they could make a charge for; and, whenever a new machine came out, up went the tariff. The so-called dustless purifiers were a great boon to the insurance offices, for they certainly minimised the risk. Certainly, 95 per cent. of the fires he had known of in flour mills originated in the stive-room; and as with purifiers no stive-room was required, all those fires would be abolished. Mr. Stringer said it was difficult, if not impossible, to purify properly, and send the air free of dust into the mill; but that was a difficulty some

engineers thought they had got over, and in a simple manner. The manner of doing it was shown in the cross-section on the wall; the width of the sieve was only half that of the breadth of the machine, and therefore the sieve had double the quantity of air through it which it would have if it were the whole width. By that means, the middlings were made perfectly pure, and yet the exhaust was free from dust.

Mr. H. HUMAN (Guardian Fire-office) said it was interesting to hear that 95 per cent. of fires occurred through stives, and yet from recent statistics in some milling papers it appeared that out of 234 fires which had occurred during the last fourteen years, the causes of about 70 per cent. were unknown. Another important point was the large proportion which took place between six in the evening and six in the morning; other statistics showed that rather more than half occurred when the mill was not at work. He believed there was a great difference of opinion amongst millers as to the advantages or dangers of stives, but from the fire-office point of view he should imagine there was less danger of explosion if the dust were in the stive than when it was in the mill itself. Purifiers were said to be advantageous to the fire-offices, but if they were not working properly they would be discharging flour dust into the room, and then the whole mill became a gigantic stive. If the miller saw this he would, of course, try to stop it, but at night it was very difficult to see this fine dust. The question of lighting, therefore, was very important in connection with purifiers, for if the air became charged with fine dust, and a light were taken in, an explosion might take place. It was evident that the risk of fire in mills was considerable, and he was inclined to think that instead of having a low normal rate, and a tariff for machines used, it would be better to begin with a high normal, and then add something for admittedly extra risks. He thought the time was coming when the matter would be dealt with in a different manner.

Mr. ALFRED R. TATTERSALL said the whole milling industry were proud of Mr. Carter, who had been the pioneer of the roller system, and all acknowledged the good work he had accomplished, both among operatives and employers. The difficulty he (Mr. Tattersall) sometimes found in inducing stone millers to take up roller milling showed him what Mr. Carter must have had to encounter in the earlier days in introducing the new process. He could not agree with him as to the process of scalping after the break rolls; spout scalpers were scarcely introduced as yet, but they must recognise that they met the point which had been mentioned of dealing gently with the stock. He had recommended grading before purification, and should like to know his opinion as to the best grader, the reel, the rotary, or the sieve. If you put the semolina or middlings on a reel grader after scalping he thought it would do more

harm than good. He was naturally prejudiced in favour of the "Koh-i-nor" machine, and recommended an examination of it, and of the "Victoria" purifier. With regard to insurance, he endorsed Mr. Stringer's remarks that the inspectors were terribly ignorant, and in particular they did not insist sufficiently on cleanliness, the absence of naked lights, and automatic lubrication. In conclusion, he wished, on behalf of a large number of young men in the trade, to express their gratitude to the City and Guilds Institute for including milling in their curriculum, for it had been a most potent influence for good, and many men he met showed him with pride the certificates they had received, signed by Sir Frederick Bramwell.

Mr. SANDERSON (secretary of the Millers' Association) said Mr. Carter, no doubt for want of time, had passed very lightly over one important branch of his subject, viz., the gradual reduction of the middlings to flour. It would have been of interest to hear how the distinct part of the grain, called the germ, was got rid of, and how the particles of semolina to which bran adhered might be gradually separated into what the Germans called dust, and, ultimately, made into the finest flour. Many important points were entirely overlooked by fire inspectors; for instance, too small bearing surfaces where there was heavy pressure, which, from his observation, he was convinced was often the cause of fire.

Mr. MARRIAGE said the difficulty of discussing this paper was that it covered so much ground. He believed the fire-office inspectors were anxious to do what was fair; but they could not expect these gentlemen to understand the details of all the mills in the country—cotton-mills, cement-mills, flour-mills, and so on—and he believed the present system was adopted with a view of getting at a fair mode of rating. He did not, however, think they were successful, and they would probably do well to consult milling experts, and construct a new tariff on better lines. He did not think engineers invented new machines to get round the tariff, but rather to get round the millers, who were often quite bewildered what machine to adopt. He did not know why Mr. Carter had made such an attack on the London Corn Trade Association; if the Indian wheat did not come over dirty, these machines for cleaning it would not be required. He took it, it was a matter which lay with the Indian husbandman, for he could not think there was much actual roguery, or that it would pay anyone to add dirt purposely to the wheat. There were many things he did not understand in connection with milling machinery, and amongst them, how the dustless fans could draw the intermediate product into the trays without taking with it part of the pure oval.

The CHAIRMAN said Mr. Carter had spoken of ancient milling in a somewhat modified sense, for he

referred to times when an exhaust was used ; but that was a somewhat modern invention. He was apprenticed to a millwright, and an efficient flour-mill plant then consisted of sack tackle, some kind of wheat-cleaning machines, a pair of millstones, a bin to receive the stuff in, sacks to put it into, tackle to hoist it to the top, where it could be stored until it was fit to dress, and a bolter or wire dressing machine. Mr. Carter had hardly done justice to the bolter, and spoke of it as rubbing against the staves ; it really beat against them, being compelled to revolve in a limited area, bounded by beaters which used sometimes to splinter, and he was thought to have done a good thing in introducing brass tubes instead. The exhaust was not used simply for cooling ; some present must recollect the combination of blast and exhaust, which was employed not merely to cool, but to dry and to increase the quantity, and also to get rid of that large traverse which the flour was subjected to before it escaped from the stone. The notion was that without a current of air through the stones the grain, even when practically broken up and containing a portion fit to be driven out, was compelled to remain in and to be "killed ;" but that if there were a current of air through the eye of the stone, it would lay hold of all that which was sufficiently ground and drive it out. What Mr. Carter had said about particles of the same gravity but of different size not being equally affected by a current of air was perfectly applicable. The weight of a particle increased as its cubic contents, but the surface to be acted on by the air only increased as the square, and, therefore, although the specific gravity might be the same, there was a very different opposition to the action of the air when the size varied. It was the same in washing ores, if you wanted to obtain a uniform result from a stream of water, or a blast of air, you must, as a preliminary process, grade the things to be operated on into something like uniform sizes. On the question of fire mischance, a good deal might be said. He remembered, when manager of a factory on the river side, and wanting to insure his household furniture, he found he was going to be charged the treble hazardous rate, and on inquiry was informed it was because he lived on the bank of the river. Of course he took that as a compliment, as they must have thought he was going to set the Thames on fire. If the offices, however, were wrong, millers were tolerably numerous, and could establish an office of their own, by which means they would soon see if they could pay a dividend on lower rates than they were now charged. It had been suggested that new machines were invented to circumvent the fire offices, and in the same way he had heard that roller milling itself was invented in order to escape a tax, which in Italy was levied on millstones, but he could not say whether that was really the case. At any rate it was a vast improvement on the old system. Beautifully fine and good coloured flour could now be obtained from which bread really fit to eat could be made, which

did not smell sour, and was free from all those imperfections which used to pervade London bread. Even now, you sometimes found in the country bread which was hardly eatable, being made from flour ground in the old-fashioned way. No one could doubt the superiority of the modern product ; and it was high time that the process should be explained before the Society. He would, therefore, conclude with proposing a hearty vote of thanks to Mr. Carter, who was certainly the gentleman best fitted to bring the subject forward.

The vote of thanks having been carried unanimously,

Mr. CARTER, in reply, said he was very glad to hear the Chairman's remarks, not only in praise of modern flour, but in commendation of the bolter. He had more than once thought whether the old bolter could not be brought out again in a new material, but on inquiry he found that other materials had been tried, and found not durable enough to stand the rubbing or beating against the outer wooden staves. He was especially thankful to the Chairman for coming to his aid with respect to the grading of the products to be purified, and explaining so lucidly and scientifically the difficulty which met millers and engineers every day. He had used both sifters and reels, but had never succeeded in grading middlings as completely as he could wish. Mr. Carl Haggenmacher, of Buda-Pesth, who had devoted years to this question, had put into his sifting graders what was known there as a Haggenmacher "galop," a kind of twisting action, which sent the semolina up and brought it down in a line as nearly as possible normal to the surface of the silk. With regard to drying, he agreed with Mr. Stringer ; he did not advocate a thick layer, but a roomy kiln, in which the wheat should be spread thinly ; and he had been drawing a room in which there might be a number of layers one above the another. He could not answer Mr. Rawlings's question as to the inflammability of dust from stones or rollers being the greater. He thought there was more heat from stones, but, on the other hand, there were very few explosions from millstones, and as far as he knew, there had been none from stive-rooms in roller mills. He did not think there was any risk from scalpels, whether rotary or any other kind. He should like to emphasise what Mr. Tattersall had said about the action of the City and Guilds Institute and the action of the Chairman when the Millers' Association brought the matter forward, and the immense benefit it had been to the trade. He did not go into the question of the reduction in the smooth rolls, for want of time, but it should be done gradually, and in each case should be followed by purification down to the last rolling but one. The number of fires which occurred when mills were not at work only showed the truth of what he had pointed out that fire-offices should insist more on

cleanliness. Bearings, with grease and dust adhering to them, and lubricators and oil-cans not used, accounted for many of the fires which broke out after a mill was closed. Mr. Marriage had objected to what he said about the London Corn Trade Association, but he gave them notice of it; and no one had come to deny what he had said. It was evident Mr. Marriage had not read the report which the Association issued, because in it they admitted, and millers who had investigated the matter would tell them that the native dealers actually mixed stones and dirt with the wheat to bring up the 5 per cent. allowed. The millers throughout the kingdom advocated cleaner wheat, and every inducement was held out to secure it. Any miller would give a better price for clean wheat than he would for dirty.

The CHAIRMAN said he had listened with much pleasure to the observations made with respect to the technological examinations of the City and Guilds Institute, which were first instituted by the Society, and then taken up by the Institute. Milling was only one out of about forty industries in which examinations were held, examinations which had undoubtedly been of immense service to the country.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock :—

MARCH 11.—H. NEWMAN LAWRENCE and ARTHUR HARRIES, M.D., "Electricity in relation to the Human Body." W. H. PREECE, F.R.S., will preside.

MARCH 18.—F. H. CHEESEWRIGHT, "Harbours Natural and Artificial." Lord ALFRED CHURCHILL will preside. *

Papers for meetings after Easter :—

"The Sources of Petroleum." By WM. TOPLEY, F.R.S.

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"The Use of Petroleum in Prime Motors." By WILLIAM ROBINSON.

"The Durability of Pictures Painted with Oils and Varnishes." By A. P. LAURIE.

"Bimetallism." By SIR GUILFORD MOLESWORTH, K.C.I.E.

"Armenia." By CAPTAIN J. BUCHAN TELFER, R.N.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at Half-past Four o'clock :—

MARCH 17.—Sir EDWARD N. C. BRADDON,

K.C.M.G., Agent-General of the Colony, "Recent Development of Tasmanian Industries."

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Papers for which dates are not yet fixed :—

LEWIS ATKINSON, "The Diamond Fields of South Africa."

C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

WILLIAM WYLDE, C.M.G., "The Opening of Africa."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 30.—COL. J. O. HASTED, R.E., "The Periar Project." The Right Hon. SIR MONTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MARCH 10.—J. STARKIE GARDNER, "Enamelling and Damascening." Professor H. HERKOMER, R.A., will preside.

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, F.S.A., "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

POPULAR AFTERNOON LECTURES.

Friday afternoons, at half-past 4 o'clock :—

Captain ABNEY, C.B., D.C.L., F.R.S., "The Science of Colour."

March 6, 13.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

LECTURE I.—MARCH 9.—Photography as a branch of Technology—Methods of giving instruction

in the subject—The preliminary training essential—Photographic materials—Silver and its compounds—Reduction and oxidation occur simultaneously—The forms of reduced silver; grey and black deposits—Supposed allotropic modifications of reduced silver—The haloid salts of silver; their behaviour towards reagents; influence of solvents; formation of double salts—The state of molecular aggregation—Order of reducibility.

LECTURE II.—MARCH 16.—The existence of sub-salts of silver—Coloured forms of the haloids—Photosalts—Colloidal organic compounds of silver—Silver albuminate and “gelatino-nitrate”—The principle of emulsification—Other photographic materials—Photo-physical and photo-chemical change—Modification of crystalline form under the influence of light—The action of light on asphalt—Photo-chemical study of iron compounds—Photo-chemical study of mercury and copper salts.

LECTURE III.—MARCH 23.—The action of light on the silver haloids—Accelerators and retarders of photo-chemical decomposition—The invisible products of the action of light on the haloids—Sensitive films—The function of the vehicle in modern emulsions—The invisible effect of light on the haloids—The photographic image—Development and subsequent processes.

HUGH STANNUS, F.R.I.B.A., “The Decorative Treatment of Natural Foliage.” Four lectures.

April 13, 20, 27; May 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 9... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. R. Meldola, “Photographic Chemistry.” (Lecture I.)
Lantern Society, 20, Hanover-square, W., 8 p.m.
Mr. E. W. Maunder, “Photography as applied to Astronomy.”

Royal Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Dr. R. Milne Murray, “A Galvanometer.” 2. Mr. M. R. Jefferds, “How to Decrease Railway Rates, and Increase Dividends thereby.”

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Henry Schlichter, “Ptolemy’s Topography of Eastern Equatorial Africa.”

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m.
Mr. A. J. Spencer, “The Law of Joint Stock Companies.”

TUESDAY, MARCH 10... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.)
Mr. J. Starkie Gardner, “Enamelling and Damascening.”

Royal Institution, Albemarle-street, W., 3 p.m.
Prof. Victor Horsley, “The Structure and Functions of the Nervous System.” (Part I.) “The Spinal Cord and Ganglia.”

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall Rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Major-General Sir J. Bevan Edwards, “Australasian Defence.”

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. John Thornhill Harrison’s paper, “The Subterranean Water in the Chalk Formation of the Upper Thames, and its Relation to the Supply of London.”

Society of Architects, St. James’s-hall, Piccadilly, W., 7½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m.
Sir David Salomons, “The Registration of Slides in the Optical Lantern.”

Anthropological, 3, Hanover-square, W., 8½ p.m.

1. Mr. C. H. Read, Exhibition of Objects collected during the Voyages of Vancouver, with Notes.
2. Mr. J. J. Lister, Notes on the Natives of Fakaofu (Bowditch Island), Union Group.

Sanitary Institute, 74A, Margaret-street, W., 3 p.m.

Dr. A. T. Schofield, “Physical Culture.” 8 p.m.

Mr. J. F. J. Sykes, “Nature of Nuisances, including Nuisances, the Abatement of which is difficult.”

WEDNESDAY, MARCH 11... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Messrs. H. Newman Lawrence and Arthur Harries, “Electricity in Relation to the Human Body.”

Geological, Burlington-house, W., 8 p.m. 1. Messrs. A. V. Jennings and G. J. Williams, “Manod and the Moelwyns.” 2. Mr. S. S. Buckman, “Notes on Nautili and the Ammonites.” 3. Mr. J. W. Gregory, “The Tudor Specimen of *Eozoon*.”

Pharmaceutical, 17, Bloomsbury-square, W.C.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, MARCH 12... Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m.
Mr. W. M. Conway, “Succession of Ideals in the Ancient Worlds.”

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. Holl, “The Elements of Pictorial Beauty.”

Royal Institution, Albemarle-street, W., 3 p.m.
Prof. C. Meymott Tidy, “Modern Chemistry in Relation to Sanitation.”

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MARCH 13... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Popular Afternoon Lectures.) Captain Abney, “The Science of Colour.” (Lecture V.)

Sanitary Institute, 74A, Margaret-street, W., 3 p.m.

Dr. A. T. Schofield, “The Care of Old Age.” 8 p.m. Mr. A. Wynter Blyth, “Diseases of Animals in relation to Meat Supply; Characteristics of Vegetables, Fish, &c., Unfit for Food.”

United Service Institution, Whitehall-yard, 3 p.m.

Major G. E. Malet, “The late Royal Military Exhibition, and its Value from a Military Point of View.”

Royal Institution, Albemarle-street, W., 8 p.m.
Weekly Meeting, 9 p.m. Dr. Felix Semon, “The Culture of the Singing Voice.”

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students’ Meeting.) Mr. W. A. P. Tait, “The Lanarkshire and Ayrshire Railways.”

Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

New Shakspeare, University College, W.C., 8 p.m.
Miss Phipson, “Shakspeare References to Natural Phenomena.”

SATURDAY, MARCH 14... Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, “The Forces of Cohesion.” (Lecture V.)

Journal of the Society of Arts.

No. 1,999 VOL. XXXIX.

FRIDAY, MARCH 13, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

PROFESSOR R. MELDOLA delivered the first lecture of his course on "Photographic Chemistry" on Monday evening, 9th inst.

The lecturer began by laying down the principles which should govern the technical teaching of photography, and expressed his regret that no institution for photographic training, similar to many in Continental cities, existed in England. His lecture was devoted to experimental illustrations of the sort of teaching it was desirable all attempting the serious study of photography should undergo.

The lectures will be printed in the *Journal* during the autumn recess.

POPULAR AFTERNOON LECTURES.

CAPTAIN ABNEY, C.B., F.R.S., delivered the fourth lecture of the course on "The Science of Colour" on Friday afternoon, 6th inst.

Captain Abney continued his explanation of the method he had devised for matching and measuring colour, giving further experimental illustrations of it. He then took up the question of primary colours, and demonstrated that the only colours in the spectrum which could not be imitated by combinations of other colours were red, green, and violet; so that these alone had any right to the title of primary.

The fifth (and concluding) lecture will be given to-day (Friday), at 4.30 p.m.

FOREIGN & COLONIAL SECTION.

The next meeting of this Section, on Tuesday, 17th inst., at which a paper on "Recent Development of Tasmanian Industries" will be read by Sir EDWARD N. C. BRADDON, K.C.M.G., will be held in the evening at 8 p.m., instead of in the afternoon at 4.30 p.m.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1891 early in May next, and they therefore invite members of the Society to forward to the Secretary, on or before the 18th April, the names of such men of high distinction as they may think worthy of this honour. This medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to Michael Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michael Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., then Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hoffmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (now Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister.

In 1887, to HER MAJESTY THE QUEEN.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, F.R.S., LL.D.

In 1890, to William Henry Perkin, F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

Proceedings of the Society.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 11, 1891; WILLIAM HENRY PREECE, F.R.S., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Green, Joseph F., Heathlands, Gervis-road East, Bournemouth.

Jackson, Robert Cattley, 7, Loraine-crescent, New-castle-on-Tyne.

McMullen, J. A., 10, Hanover-square, W.

Pridmore, Albert E., 2, Broad-street-buildings, E.C.

Ridge, Samuel Hartshorne, B.A., 257, Victoria-parade, East Melbourne, Victoria.

Thomas, Carmichael, Palace-gardens Mansions, The Mall, Kensington, W.

Trevor, Arthur Charles, Karachi, India.

The following candidates were balloted for, and duly elected members of the Society:—

Clarke, Charles Goddard, Ingleside, Elm-grove, Peckham, S.E.

Coleman, Harry, 34, Golden-square, W.

Lipscombe, George, 41, Westbourne-terrace, W.

Worsley, Arthur Henry, 135, Ladbroke-grove, W.

The paper read was—

ELECTRICITY IN RELATION TO THE HUMAN BODY, ITS DANGERS AND ITS USES.

By H. NEWMAN LAWRENCE, M.I.E.E., AND ARTHUR HARRIES, M.D., A.I.E.E.

The subject we have chosen for this paper is one of much interest at the present time.

It is intimately connected with the practical utilisation of one of the most valuable developments of modern science, and it also concerns each of us individually.

The connection between electricity and the human body might at first sight seem rather remote, and any attempt to show a close relationship would, a few years ago, have been thought unnecessary and unprofitable.

Now, however, that electric light is in our houses, electric power in our workshops and in our streets, electric telegraphs and electric telephones in our offices, and a considerable section of the public is making more or less use daily of these appliances, it is but natural to turn attention to a consideration of the influence this powerful, yet mysterious, agent has upon the human body.

The full consideration of such a subject would be far more than could be possibly dealt with in this paper, though records of facts connected therewith are few and far between. Our subject possesses little or nothing in the nature of a history, so we hope we may be excused if we deal with the matter mainly in the light of our own experiments and observations.

It is manifest that any consideration of the relation between electricity and the human body must divide itself into two parts: the one, *possible dangers* to the body, and the other, *possible advantages*.

We deal with the dangers first:—

First among the dangers is that from lightning; but this is one which we need hardly enlarge upon here. That lightning is distinctly dangerous, and often fatally so, to the human body, is a well recognised fact, and one which is, for the most part, sufficiently guarded against. The physiological problems connected with lightning stroke are many and interesting, but beyond our present scope.

We have rather to deal with dangers arising from accidental contact with conductors which are used to convey electric currents to and from the various lamps, machines, or apparatus they are intended to actuate.

Danger from contact with telegraph, telephone, and electric bell conductors is infinitesimal; for the currents they carry ordinarily are so small, that the worst that could happen, on making contact, would be a slight shock to the nervous system. The smallness of the currents carried would prevent any real electrical danger. Still, it sometimes happens that such conductors receive, through accident to other wires,

currents many times greater than they ordinarily carry. Under these circumstances, contact with them becomes distinctly dangerous. While, therefore, we cannot speak of serious consequences likely to result ordinarily from contact with telegraph, telephone, and bell wires, we think they are best left alone by others than those whose special duty it is to look after them.

Conductors of light and power circuits do, however, convey currents which possess great possibilities of danger to the human body, and, therefore, should be so placed and so insulated as to render it impossible for members of the general public to come in contact with them.

That electric engineers (in England at any rate) have done, and will do all that is possible to safeguard the public we gladly believe and acknowledge. With proper care on the part of the engineer, and with a minimum of caution on the part of the public, accidental contact by the human body with conductors carrying dangerous currents becomes almost an impossibility; but it does not by any means follow that information as to the consequences to the body of any such accidental contact should not be made known. To be forewarned is to be forearmed.

The results of contact with currents passing at a fixed rate of E.M.F. (as is generally the case in light and power circuits) depend upon resistance, sensation, and local effect. Upon the resistance offered by the body depends the quantity of current passed; sensation and local effect are produced upon the body by such current as it really receives.

Resistance, in its turn, depends upon the condition of the skin at the sites of contact, and upon the extent of the contact area. These points are all-important in deciding the seriousness or otherwise of accidental contact.

We have noted with regret that there is a tendency among electrical engineers to draw unfair inferences from the slight results which have sometimes followed accidental contact. They argue that, because A received no harm from an accident on a particular circuit, therefore no harm can come to B and C, or any one else, on the same or some similar circuit, quite forgetting that A's hands may have been exceptionally dry, or that the area of his skin in contact may have been very small.

We have made experiments on both these questions, and find as follows:—

CONDITION OF SKIN TABLE.—ELECTRODES OF 45 SQ. C. HELD IN EACH HAND; DYNAMO CURRENTS AT FROM 100 TO 115 VOLTS.

	To continuous current resistance.	To alternating current resistance.
Dry	6,185 ohms.	4,008 ohms.
Moist	2,450 „	1,622 „
Wet.....	1,510 „	1,360 „

From this it appears that, with continuous current, resistance with the skin moist at point of contact is about one-third the average of that found when the skin is dry. With wet skin, resistance is further reduced to one-fourth. With alternating current, the proportionate decrease of resistance between the conditions of dry, moist, and wet skin, is slightly less, but is still well marked.

These results were obtained, as before mentioned, with dynamo currents at about 100 volts; and it is interesting to note that nearly the same proportion appeared in the "Comparative Resistance Table," obtained with battery-and-coil currents, which we had the honour of putting before the Institution of Electrical Engineers in a paper in March, 1890; though the actual values there given were much higher with continuous currents.

Some surface area tests were briefly referred to in our paper read before the British Association in September last, on "Alternating *v.* Continuous Currents in Relation to the Human Body (Dynamo Currents)." We have now embodied therewith other observations taken since, and find that, other conditions being the same, the current passed with a given E.M.F. is as nearly as possible in direct proportion to the surface area in contact.

These results show at a glance how very large is the influence which these factors of skin condition and contact area have.

By them we find that, while it is possible for A to receive only about 4 milli-ampere from a circuit carrying a current of 100 volts if his skin be dry, and the contact area be 10 sq. c., it is equally possible for B to receive 800 milli-ampere from the same circuit, if his skin be moist and 500 sq. c. of it be in contact. In other words, the possibilities for harm are dependent upon these factors to such an extent, that when both are favourable to the subject, contact with wires carrying current in the highest degree dangerous, may produce results in no sense serious on the other hand, when both are unfavourable, the subject may receive serious if not fatal injury, from a circuit

which might be safely handled under conditions more favourable to himself.

We now come to the consideration of what happens to the body, when the resistance has been sufficiently overcome to allow a perceptible current to pass through. The results may be classed under two heads, viz. : Sensation and Local Effect.

Sensation.—We have made many experiments to determine how the sensations of individuals are affected by currents of such strength as could be borne. The results of these have already been published in detail in the papers above referred to, so we will here only summarise them.

We find with dynamo generated currents, when bare metal electrodes, having a surface area of 45 sq. c. each, are grasped in the hands so that the current passes through the arms and chest, that with continuous current at 104 volts, an average current of 0.0183 ampere produced what we have called discomfort point, while with alternating current at about the same voltage (and a frequency of 23 per second) 0.007 ampere was sufficient to produce comparable discomfort.

Further, that with the alternating current 0.0079 ampere produced muscular fixation, while with the continuous current in no case was muscular fixation, or any sensation approaching thereto, reached.

Local Effect.—The action of currents upon the parts actually brought into contact with conductors has scarcely received sufficient attention, nor have we been able to find any detailed description of the effects observed.

It is proposed in the present paper only to deal with the phenomena resulting from the application of small currents, for experiments with large currents are not easy, nor are willing subjects available, not to mention legal and other objections. It is, however, permissible to conclude that in proportion to the power of the current will the effect described be liable to exaggeration.

A.—With continuous currents we observe:—

1. Electrolysis at the parts in contact, accompanied by a gradually increasing sensation of heat, with the additional sensation of cutting, if the edge of an electrode be grasped or touched. This slowly increases until, when the current be sufficiently large, the pain becomes unbearable. If circuit be suddenly broken, heat sensation continues to increase for a short period (one or two seconds) then gradually diminishes.

2. Shock to the muscles in the neighbour-

hood is felt with sudden make or break. This effect usually persists for a considerable time. An unvarying continuous current does not produce contraction of muscle.

3. The parts become reddened, more so at the negative than the positive pole. This is probably due to two factors—(a) stimulation of arterial stream near both conductors; and (b) paralysis of vaso-motor-nerves at the negative electrode.

B.—With intermittent and alternating currents:—

1. Repeated shock, with more or less tonic contraction of neighbouring muscles, which is practically persistent during the time of contact. Closure of circuit is marked by painful jerk, felt not so much in neighbouring muscles as in those some short distance away. Thus when the hands grasp conductors with an alternating current, the jerk is felt first in the forearm muscles, then in those in the upper arm, and the latter is accompanied by pain which is occasionally long persistent after the circuit is broken (one or more days).

2. Reddening of the parts. In the case of the interrupted or alternating currents, this phenomenon is much the same at positive and negative poles, and is due probably to the same factors as in the case of the continuous current.

Light and power circuits carry currents very many times stronger than any used or named in the above experiments; and we may fairly conclude that the result of contact therewith would be severe shock to the nervous system, and strong burning sensation at the points of contact with either form of current. With alternating current there would be muscular fixation, in addition, such muscular fixation rendering the subject quite unable to release himself, and subjecting him to the full effect of the whole current passing.

Where the conditions of contact (as set forth above) are such that the body receives a large portion of the current carried, the results are necessarily very serious to the subject, and may easily prove fatal, either from the violence of the initial shock, and consequent fright, or from the continual passage of sufficient electricity to produce death by direct electrical action upon vital parts.

With regard to the relative dangers of the two forms of current (alternating and continuous), what we have above stated clearly indicates that the dangers resulting from contact with the conductors of an alternating current circuit are far greater than those

resulting from similar contact with a continuous current circuit, even if the E.M.F. of the latter be double that of the former. This part of our subject is dealt with more fully in the papers above referred to*.

THE USES OF ELECTRICITY TO THE HUMAN BODY.

The health of the body seems to be intimately connected with, and perhaps to a large extent dependent upon, electricity, or the immediate results of electrical action both internal and external. That electricity ordinarily exists in the air we breathe, has been shown by many well-known experimentalists from Lemonnier, in 1752, downwards, and we have it on the authority of Sprague, that the average electrical condition of the atmosphere has an important bearing upon the climatic qualities of any place, though he adds "as yet very little is known on the subject."

Again, ozone is a most important constituent in a healthy atmosphere, and it is probable that electrical action is one of the chief factors in its production. Physiologists have long taught us that electricity is generated in our bodies during each functional process of whatever nature. It has been shown to be present during the action of the heart by Dr. Augustus Waller in his beautiful experiments before the Medical School of St. Mary's Hospital, in October, 1888, and more recently at the International Medical Congress at Berlin.

We are ourselves engaged upon a long series of experiments, which, so far as they have gone, clearly indicate that small but measurable currents of electricity are being continuously generated in the body. We further find that these currents differ in potential according to the parts tested, and we have reason to believe that such difference of electric potential is produced at the centres of function—thus in muscle, brain, gland structures, lungs, and various parts of the digestive system, there is a separate continuous, though apparently irregular, generation of current. The extent to which this body electricity may be dependent for its generation upon the various physiologico-chemical actions taking place in the body, is a question for the future. Meanwhile we are content to believe that atmospheric electricity in the process of the transformation and re-transformation of oxygen

into ozone and ozone into oxygen, and in other ways, passes through a cycle of transmutations, starting as atmospherical electricity and finishing as the body currents mentioned. We are thus brought face to face with the fact that electricity forms a most important factor in the processes and functions which together constitute life; but there is no evidence in favour, or reasonable probability of proof, of the vaunted and oft-advertised statement that "Electricity is life."

A confirmation of our conclusions is found in the experiments of Dr. B. W. Richardson upon the effect of administering frequently used oxygen to animals. He found that oxygen alone will not continuously support life—in presence of nitrogen, of course—unless it be frequently revived by the passage of electricity through it. The same action of electricity and its revivifying power upon the atmosphere, is found after a thunderstorm, when, as is well known, ozone is largely present owing to the electric disturbance accompanying the storm.

The artificial electrical generation of ozone for restorative purposes may also be considered as one of the uses of electricity to the body. It is one, moreover, which may probably prove of considerable importance in large cities, where the atmosphere is vitiated by the exhalations of a large and crowded population. We have made certain investigations into this subject, and carried out some interesting experiments with persons placed in an ozonised cabinet (invented and patented by Mr. Lawrence), wherein the air was charged with ozone by electrical action. The results seem promising; but the number and extent of the observations necessary, prevent the rapid completion of such research, and we must postpone more definite conclusions for the present.

The next part of our paper deals with the uses of electricity in disease. Such uses are numerous, valuable, and steadily on the increase. Without trespassing upon the distinctly medical aspect of the subject, we may refer to those well known, but little understood, effects of electricity upon the nerves and muscles of the body, by means of which many diseases depending upon nerve derangement may be ameliorated or even cured. Speaking generally, continuous currents, properly applied, tend to promote disintegration and nutrition, while alternating currents act as local stimulants. But in this connection it is most necessary to bear in mind that it is only by accurate measurement of the currents used, and

* This paralysis of circular muscular fibre is an important factor, for it is one of those made use of in such electro-surgical operations as dilatation of stricture, electrolysis of hair, &c.

by careful attention to the electro-physiological or electro-chemical changes it is desired to bring about, that satisfactory results can be obtained. Electricity is capable of doing much good to the body under numerous conditions, but that it is also capable of doing much harm we have already shown. Extreme care, therefore, is necessary in making electrical applications to the body. Care in diagnosis, so that a definite idea may be obtained as to what it is the electricity is to be directed against; care in the selection of that form of current best suited to do the work required to be done; care in choosing the position of the electrodes and the direction of the current; and, lastly, care in measuring the dose precisely, both as regards current, strength, and time. For an electrician who is not also a medical man to prescribe electricity is utterly wrong. For a medical man who is not also an electrician to administer electricity is equally wrong. For one who is ignorant of both electricity and medicine, to prescribe or administer an agent so powerful for good and evil, is (or at least should be) criminal. The mysteriousness of electricity, and its subtle methods of action, render it peculiarly adapted to the purposes of the quack and the charlatan; while the indifference, suspicion, and conservatism of the medical profession, as a body, has hindered to an enormous extent the study and development of the uses of this valuable curative agent. The public have thus been thrown into the hands of men who, for the most part, know absolutely nothing, either of electricity or of the diseases they profess to cure. Still, truth must prevail; and we are convinced that, however great the value of electricity in disease may be now, its possibilities in the near future are far greater.

With the methods of electrical treatment this paper has nothing to do, but there is one use of electricity in disease not indicated above, which is new as regards its practicability, and which, moreover, opens up a field of usefulness little expected a short time back. We refer to "cataphoric medication," or the process of passing drugs in solution through the skin by means of the cataphoric power of continuous electric currents.

Experiments have been made both in Germany and America, within the last few years, by which evidence, more or less uncertain, had been obtained of the power of electric currents to carry drugs in solution with them through the skin; but as far as our information goes, nothing reliable had been arrived

at, and some of the experimenters were even uncertain as to which pole should carry the solution to the body.

In the early autumn of 1889 we conducted a series of experiments in this department of work, and found the results so promising, that we at once proceeded to use it as a method of treatment. We have been much gratified with the results of its application in many cases of actual disease. From the reports of the International Medical Congress at Berlin in 1890, we find that subsequent to our adoption of this method in practice, Mr. Edison, of New York, has been making experiments in the same direction.

We will here illustrate the methods by some experiments: Taking the facts in order, and certain conditions being observed:—

[Experiments were here shown.]*

1. We note that a continuous current, passing from one vessel to another along a moistened conductor, will carry with it from + to — sufficient of the drug in solution at the + to produce a precipitate in the solution at the — pole.

2. That a portion of the drug in solution will pass through a porous septum in the direction of current flow.

3. That a portion of a drug in solution will pass into the human body through the skin also in the direction of the current flow, the skin here representing the porous septum.

Repeated qualitative tests have shown clearly that the drug used has passed into the system, and we are now endeavouring to obtain quantitative tests which we hope may lead to the adoption of definite dosage by this method.

While on this portion of our subject, it might be well to refer to some experiments we have made to determine whether electricity can be passed from rubber to rubber in the act of massage. For this purpose, several readings were taken from both operator and patient before and after the operation; and it was found that, while in all cases the patient gained electrically by the rubbing, in most the operator gained also. In some other cases, though the operator gained nothing, or even lost a little, the loss was not at all proportionate to the gain of the patient. These results, we think, are amply accounted for by the fact that exercise seems always temporarily to increase the body currents, provided it be not sufficiently violent or long sustained to cause exhaustion. Massage acts upon the patient by improving the circulation and

* Dr. Harries' observations on the experiments are printed on page 321.

emptying the lymphatics, and so, to that extent, is akin to gentle exercise; hence the increase of the body currents noted in the patient. Massage is to the operator often more than gentle exercise, and is frequently accompanied by a certain amount of exhaustion. Any gain in body current on the part of the operator is probably due to the exercise taken; but this gain may be rendered negative by accompanying exhaustion. We are thus led to conclude that electricity does not pass from rubber to rubbed in massage.

Since writing the above, our attention has been called to an American invention, which is designed to prove of use to the body in dentistry. It is called a "Dental vibrator," and its object is to render painless that very unpleasant operation, "tooth extraction." We have examined and tested it in use, with the result that, as far as our present observation goes, we find it does fully accomplish the elimination of pain.

In conclusion, it may perhaps be well to say a few words by way of summary.

The dangers of electricity to the body are considerable, but, fortunately, they are provided against, and generally in a very secure manner. Consequently, it is probable that possible danger to the body from electricity, as carried by light and power circuits, is smaller than the dangers connected with the use of gas or oil. Still, let it not be forgotten that danger, sharp and sudden danger, lurks in the conductors of such circuits, and therefore none but properly initiated and protected persons should touch or interfere with them. If only the wires or other conductors of light and power circuits be so insulated and placed that, under ordinary circumstances, the body cannot come into contact with them, risk is light and danger small. It, in fact, concerns only the comparatively few, whose work necessitates their constant presence among such conductors.

The uses, however, affect a far larger number, and outweigh the dangers to an enormous extent. Electricity is useful to us in health; it is so closely connected with vital function and sensation that very probably life does not exist without it; it is capable of producing such changes in the body, that it takes rank as one of the best remedies in disease, and it is also of immense value in many branches of surgery.

The true relationship between this marvellous and many-sided agent of Nature, and the various complicated phenomena which

together make up the sum of our individual existence, has yet to be found. We venture, however, to think that what has so far been discovered proves the relationship to be beneficial. The more the subject is investigated and studied, the better it will be for the health and happiness of us all.

During the reading of the paper, Dr. Harries illustrated the cataphoric method of using cocaine on a subject, and explained the process as follows:—

I am only about to show you a single experiment this evening, and for the following reasons. First of all the initial experiments, which are really the basis upon which we propose to proceed to-night, are only workable with large currents. Now, it is not easy to apply these large currents to the body, because people object to have painful currents used. Further than that, it would be unfair to use such currents as would be likely to come into contact with the skin by accident; and, as a third reason, one would only wish to use such currents as might really be of service to the body. What we are going to do is to place some electrodes in contact with the skin of the gentleman who is good enough to be our subject. By means of these electrodes we shall send a current of 20 m.a. through the moistened skin. One of the electrodes will be saturated with a solution of cocaine, which is, as you know, an anæsthetic, and we hope at the end of twenty minutes or so to be able to have so anæsthetised the skin as to be able to operate upon it painlessly. We shall prove that the part is insensitive, by passing a needle through it, and still further by sending a small current through the skin. To prove that the current has been used, I shall take away one or two hairs by electrolysis, so as to give you ocular demonstration of what has been done. I will endeavour to show on the blackboard an outline of the experiments which form the basis on which the process of cataphoric medication has been built up.

We start with a couple of beakers filled with fluid nearly to the brim; one containing dilute sulphuric acid, the other a solution of barium chloride. Between the two we place a piece of lamp-wick well soaked in a solution of sodium chloride. It may be supposed that, by simple capillary action, some of the hydric sulphate may pass over into the barium chloride, but that is not so, as we proved by

leaving the apparatus in *statu quo* for twenty-four hours without any such result. Then we modified the conditions by placing in the first beaker an electrode connected with the positive pole of the battery, and in the second another electrode connected with the negative pole; and sending a current of about 100 m.a. through the arrangement. Within half an hour we had a deposit of barium sulphate; in fact, in a few minutes a little dulness could be seen in the liquid at the end of the lamp-wick; the dulness soon spread, and ultimately flakes could be distinguished. These were remarkably fine, and it was necessary to look at them with a lens to distinguish them from the bubbles of hydrogen which were given off in great quantity. That is the first step in our series of experiments. You may say that the whole thing is easily explicable by the theory of electrolysis; but that is not so, and for this reason. If we were experimenting by means of electrolysis only, we should use some solution in which the alkaline element would be carried to the negative electrode; but here we have no alkaline element present at all, with the exception of hydrogen, and that, of course, would not produce a precipitate in the barium chloride solution. There must, therefore, be something else at work. Having put capillary attraction out of the question by our initial experiment, we may ignore electrolysis because there is nothing to pass over which will produce a precipitate. We have therefore to consider the third power of a continuous current, viz., that of mechanical transference, and, as a matter of fact, we have an absolute mechanical transference from the positive electrode to the negative. The proof of that is found in the precipitation of barium sulphate in the second solution. Of course if we were going the other way about, it would be easy enough to produce a precipitate; but we have used the sulphuric acid purposely at the positive electrode, in order that there may be no possible question of any other kind of action.

The next experiment is a development of the first. Here we have a trough made of glass, divided into two parts by a porous septum, which in our experiments was made of baked clay. It is not very thick, but just sufficiently so to prevent any chance of leakage. Into one of these compartments we place a solution of iodine, and in the other is a solution of starch. The reason iodine dissolved in water was selected was that we should have no chance of complication from such solutions as might be dependent on the presence of an iodide salt.

Supposing, for instance, we had used iodine dissolved in water, together with iodide of potassium, under the conditions of the experiment, the potassium would be passed over, and we did not want that to happen. We tested this arrangement, to see if there were any precipitation of the starch in the ordinary way, by simple osmosis, and we found no result whatever. But when we placed an electrode in each compartment, one connected with the positive, the other with the negative pole of the battery, and sent a current through, we found that, within an hour, there was distinct precipitation of iodide of starch, which went on increasing for a considerable time. It was not large in quantity; that is a point to be noticed. Had it been large in quantity, it would have upset some of the points in connection with cataphoresis which I am anxious to make clear. As a result, therefore, of the action of a continuous current applied in this way, we passed iodine through the porous plate into the starch solution, and had on one side a precipitate of iodide of starch. The precipitate did not continue to increase after a certain time. There are chemical reasons for that, but it is sufficient to say that we did have a precipitate which was sufficiently copious for all the purposes of demonstration.

The third step is this. In place of the porous plate, we choose to-night for the purpose of our experiment the human skin—that is, a septum of animal membrane—and by means of this power of mechanical transference of continuous current, I hope to be able to show that cocaine can be passed through the skin in such quantity as to enable us to anæsthetise it completely. We use a small pad soaked in a solution of cocaine, which is placed on the part of the skin to be operated upon. The negative electrode is fixed a little higher up the arm, and the part between the two represents the porous septum, or lamp-wick. We have allowed a current of about 20 m.a. to pass through the skin for 25 minutes, and doubtless, on removing the pad, I shall find the skin quite insensitive to pain. The first thing one notices is that the skin underneath the electrodes is red; that is merely an exemplification of the ordinary action. Now, taking a platinum needle which can be connected with a battery, I pass it through the skin to the depth of 1-16th inch or more. The subject shows no sign of pain. Now I put on a current of 4 m.a. The first thing one

observes is a separation of gas at the point of application of the needle. On removing the instrument, I find that the hair easily comes away from the skin, the root being more or less decomposed. I will take away another hair in the same way, passing the needle well down to the base of the follicle.

DISCUSSION.

Mr. HOWARD SWAN said he had watched the progress of these experiments from the beginning with great interest, and believed the investigation was likely to prove very useful. The power of treating a small portion of the human body, so that it might be actually cut into without causing pain, needed no words to recommend it to medical men. Though in ordinary houses there was no danger from electric wires, it was useful for the public to know what dangers lurked in the wires, with which they had no business to meddle, especially as recent experiments showed that currents of far greater pressure than we had been accustomed to—even up to 25,000 volts—were likely to come into use. He had heard of several sets of experiments with regard to electricity being generated in the human body, but did not know whether the actual amount of current had been determined. A friend of his, late cable superintendent to the Eastern Telegraph Company, told him that he had sometimes amused himself by testing both negroes and himself, and found that the potential of Europeans was considerably greater than that of negroes. It varied in different states of health and activity, and it occurred to him that it might be an aid to diagnosis. If the normal current in a healthy state had been determined, it would probably be found to vary in disease. One question was how far the process of digestion gave rise to these currents. If there were any reason to suppose that the human stomach, at a temperature of 100°, was a primary battery, it might afford a useful hint to electricians, and if they employ, not necessarily a solution of corn, but say of coal ground fine, in a battery of which the prototype was the human digestive organ, there might be a great development of primary battery schemes. Dr. Milne Murray read a paper lately at Glasgow, in which he brought forward a very delicate galvanometer of the type spoken of by Mr. Lawrence, in which there was a special arrangement for determining minute physiological currents, and if any further information could be given on that point it would be interesting.

General PHILIP SMITH, C.B., bore testimony, from personal experience, to the value of electrical treatment.

Mr. J. J. VEZEY asked how long the insensibility of the skin lasted.

Mr. JONES inquired if the application of cocaine to the skin for twenty-five minutes, without any electrical action, would not produce a certain amount of anæsthesia.

Mr. BRUCE asked if instantaneous photography had been applied in any of these experiments, in recording the physiological effects produced by the current.

Mr. F. WYLES asked if the electrodes were of platinum, and said he had made somewhat similar experiments, using a wet string instead of the lamp-wick. It had been found necessary to use a new wet string on each occasion when any important reading had to be taken. He suggested that a syphon tube might be used.

Mr. HENCHMAN thought that possibly the results shown were due in great measure to the action of the cocaine alone. He had been operated upon several times, once or twice seriously, always with the local application of cocaine, and the pain had been very slight.

The CHAIRMAN said both the dangers and benefits of electricity were now attracting a good deal of attention, and each topic was a very old one. Nearly 150 years ago, the first severe operation of the electrical discharge attracted the attention of all Europe, and even in 1759, no less a character than John Wesley wrote a book under the title of "The Desideratum; or Electricity made plain and useful, by a lover of mankind and of common sense." Some of the sections of that book were peculiar and interesting. For instance, "Electricity the soul of the Universe;" "The cat in the oven; curious electrical experiment;" "A person with the smallpox cannot be electrified." He did not know whether the author had worked in that direction. Again, "Electricity the greatest of all remedies;" and again, one experiment described by Wesley was—"A person standing on the ground cannot kiss an electrified person standing on the resin." There was this great distinction between this paper and nearly all that had hitherto been written on the curative qualities of electricity, that it had been illustrated by experiment, and was the result of actual observation. Too often people allowed their imagination to run wild on these matters. The dangers of electricity had occupied a great deal of attention lately, and the Press had given great prominence to accidents which had occurred in the United States. Nearly all these accidents had arisen from men occupied

in repairing and maintaining telegraph and telephone wires, who had received severe shocks, and had been killed, either instantly by the current, or by being thrown from great heights to the ground. But, in these cases, the currents were not from the telegraph wires themselves, but from electric light or power circuits which ran on the same poles. Those who had not been in the States, could scarcely believe that a nation so far advanced in civilization would actually allow a street like the Strand to be permeated by poles, each carrying a mixture of wires—some telegraphic, some telephonic, some for fire alarms, and many for electric lights and the transmission of power. The result was, you could walk down Broadway almost sheltered from the sun by the cloud of wires overhead. When a poor telegraph man ascended a pole to remove a fault, he might accidentally touch a wire carrying a powerful current, from which he received a fatal shock; but, of some 30 accidents he had investigated, about nine-tenths had arisen from this cause. Of course, the cure for such dangers was very simple. The first rule was, never to allow such wires to be carried overhead. All light and power wires worked at high pressure should be carried underground, away from the reach both of the public and the workmen. But in this country there was an element of safety which existed nowhere else that he knew of, and which few people liked—the grandmotherly government of the Board of Trade. But there never was an institution which did more for the life and health of the country than the Board of Trade. Its rules and regulations had made a first-class railway carriage absolutely the safest place to live in; for more people died in their own dining-rooms than in railway carriages. The same with electric wires; if they were put up in accordance with the rules of the Board of Trade there would be almost absolute safety. One important point in connection with the danger from wires was the duration of contact. You might have a current of high E.M.F., and just touch the wire with more than a trifling effect; but if you grasped it, and got muscular fixation, the result would be very serious. Another point of great importance, which had been lately investigated by an American electrician, Mr. Tesla, was the influence of alternating currents of high frequency. The authors spoke of an alternating current of a frequency of 23 to the second; but those used by the Grosvenor Gallery Company were about 70 or 80, and at present the ordinary frequency used was about 100. Mr. Tesla found that the higher the frequency, the greater was the amount of electrical energy which might be passed through the body without serious discomfort, which was a point deserving attention. The authors had touched very lightly on a delicate subject, the nature of electricity. Those who spent their lives in dealing with electricity knew least about it, and people did not even agree on what the term electricity meant. Practical men called one thing electricity, and the physicist and mathematician

applied the term to something else. Passing through the carbon filaments which lighted the room, there was something which many called electricity, but it was really electrical energy. In the same way, heat was one thing, and temperature was quite another thing. Electricity was one thing, and electric energy was another. Engineers regarded the electricity which was used in lighting distinctly as a form of energy; it was not a substance, a body, but something of an abstract character, which could not be explained; but it had these properties which the authors of the paper had spoken of, curative power^s of various kinds, and the peculiar cathaphoric power which had been shown by the experiments. The authors trod on very safe ground when they applied their powers of experimenting to solve this intricate question. Tooth extraction had been spoken of, and a friend of his had tried the electrical method and found it so successful, that he had eight troublesome teeth removed at one sitting. He concluded by proposing a hearty vote of thanks to the authors of the paper.

The vote of thanks having been carried unanimously,

Dr. HARRIES, in reply, said it had not been possible, with the instruments at their command, to determine the exact difference of potential at different parts of the body. They found deflections varying from 15 or 20 up to perhaps 40 degrees on the scale of the mirror galvanometer, but what that represented he was unable to say; each degree might be one-millionth part of a unit, or perhaps less, but at present that was only a guess. With regard to the difference noted between negroes and Europeans, that might in all probability be accounted for by a difference in skin resistance. The skin of a negro was usually much thicker than that of a white man, and was the chief factor in the resistance to the passage of currents generated inside the body. The question relating to the process of digestion would admit of a great variety of answers, but he should suppose that where digestion was going on there would be electrolysis, and if so there would be loss of current, not production. On the other hand, where oxidation was going on, as in the lungs, and in the tissues where action was vigorous, where the oxyhomoglobin of the blood was being reduced, you might expect to find production of current. He had not yet seen Dr. Milne Murray's galvanometer. As a rule anaesthesia began to diminish after about ten minutes, and went on diminishing for half an hour or 40 minutes, depending in different cases on the degree of soakage. The anaesthetic result depended, to a great extent, on good preliminary soakage of the skin, which, lowering its resistance, enabled the solution to pass more readily into the tissues. Where the skin was dry, the process would take longer, and be

more difficult. Whether the insensibility was due to the cocaine alone, was a vital point. If the result were due to electricity alone, they would not need to use the cocaine; and if it were due to the latter alone, there would be no occasion to use electricity; it was due to combined action. The application of cocaine alone of the proper strength would have some effect; but when used with the aid of the current it produced such anæsthesia that you could, if necessary, apply a red-hot iron, without much objection on the part of the patient. By using this cataphoric process, the *galvano-cautère* had been applied as much as half-a-dozen times, consecutively, to the same patient, at the same operation, without any sign of wincing. He had seen no reports of the application of photography in noting the effects produced by electricity; but he should be very glad if someone would carry out experiments in that direction, which could hardly fail to be useful, especially in determining the exact dose of current which a patient could bear. As mentioned by Mr. Wyles, they used a fresh wet string, or wick, at each experiment, as well as platinum or carbon electrodes, avoiding anything liable to easy decomposition. With all deference to John Wesley, he was not right in saying that persons suffering from smallpox could not be electrified. Probably, in those days, insulation was not so perfect as it was now, and the whole subject was not so well understood. Wesley knew a great deal about many things, but he could hardly be called an expert on the subject of electricity. On the subject of kissing, he might have had more experience, and his evidence perhaps would be more readily accepted. The duration of contact was an important point, which had been alluded to in the present paper, as well as in previous papers referred to. With regard to currents of high frequency, he had dealt with that question both at a meeting of the Institution of Electrical Engineers last March, when he stated that the more rapid the alternations, the more nearly did the conditions resemble those of a constant current as regarded sensation; and at the British Association meeting at Leeds the subject was also dealt with. It was stated that a much larger dose of electrical current could be taken when the alternations were 300 per second than when they were 50 or 60. Everything new, of course, came from America, but in this instance he thought they had got ahead of Mr. Tesler. Certain other specially electrical matters he would leave his colleague to deal with.

Mr. LAWRENCE said he had very little to add. They had referred in the paper to the danger which might arise incidentally from telegraph wires being in the neighbourhood of those carrying stronger currents, and in regard to the point raised by the Chairman about the nature of electricity, he should be very sorry for it to be supposed that they had the remotest intention of attempting any explanation of

the kind. They had only referred to electricity as it was used; and as the Chairman had differentiated between electricity and electrical energy, he might explain that they intended to speak only of electrical energy.

APPLIED ART SECTION.

Tuesday, March 10th; H. LONGDEN in the chair.

The paper read was on "Enamelling and Damascening," by J. STARKIE GARDNER.

The paper and discussion will be printed in the next number of the *Journal*.

Miscellaneous.

THE VEGETABLE FIBRES OF TRINIDAD.

The United States Consul in Trinidad has recently forwarded to his Government a report upon the vegetable fibres of that island, and gives a description of some of the most important of them. The *maholtine* is a plant which grows wild in large quantities. It is easily cultivated, by simply cutting down bushes and burning them, and scattering the seeds of the plant. One acre of good ground will produce about 5,000 pounds of stalk; and this stalk, reduced to fibre, will make about 800 pounds. The stalk grows from eight to twelve feet, the skin or bark of which is stripped off, and steeped in cold water, eight or ten days after which the green watery substance is washed out, leaving a fibre eight to ten feet long. The white *mahoe* (*Sterculia caribæa*), like the *maholtine*, grows wild, and may be cultivated in the same way, producing the same quality of fibre. The fibre is whiter and more silky than that of the *maholtine*, and is believed to be superior to it, although it has never been sent abroad to test its merits. A crop is reaped every seven months. The *gumbo* or *okra* (*Abelmoschus esculentus*) is another stalk fibre, the plant growing six to eight feet high, and producing a fibre about the same length. Cultivated on good soil, it will produce 4,000 pounds of stalks, yielding as much fibre to the pound as the *maholtine* or the white *mahoe*. The fibre of the *gumbo*, unlike those above mentioned, will not contain water, but throws it off like oil silk. A crop is harvested every seven months. The plantain (*Musa sapientum*) will produce from five to six pounds of fibre to each stalk. The stalks grow from eight to nine feet high, and 800 of them may be produced on an acre of ground. The fibre is obtained by putting on two wooden rollers, and rolling and squeezing

the stalks to crush the watery pores, then steeping it in water eight to ten days, and, finally, putting it under the same rolling process with heavier weights. The banana (*Musa paradisiaca*) grows four to five feet high, produces two to three pounds of fibre to the stalk, and 800 stalks to the acre, and the crop is annual. Ramie or china grass grows very thickly, and when once planted sustains itself against other grass. After the first year it can be cut every six months. The stalk grows about four feet high. It will produce an ounce of fibre to every square foot. The plant was imported into Trinidad from China for experimental purposes about three years ago, and has not yet assumed any commercial importance. The *mahoe bord du mer* (*Paritium tiliaceum*) does not grow inland, but on the sea shore. It is a stalk fibre, but unlike the above it branches, and the branches also produce fibre. It grows eight to fifteen feet high. Each tree will produce about half a pound of fibre, and one acre can support 800 trees. Red *mahoe* (*Sterculia caribæa*) grows wild on any soil of the island, produces about 800 trees to the acre, grows eight to ten feet high, and then branches. The stalk and branches are both used for fibre, which is used by the natives for making rope. The crop is annual. *Rucon*, or *annotto*, an Indian plant from South America, is a very strong fibre. One acre will support 800 stalks cultivated on fertile soil, and each stalk will produce about half a pound of fibre. Black sage (*Cordia cylendros*) is a small shrub about six feet high, and produces a very strong fibre, used by the natives for making ropes. An acre of ground will support 1,600 plants, and they will give one-fourth of a pound of fibre to each plant. *Bois sang*, or blood wood, grows twenty-five feet high, and branches out eight to ten feet from the bottom. When tapped, the tree emits a fluid resembling blood, which produces a red stain. Both stem and branches produce fibre. About 600 trees may be produced to the acre, and each tree will produce two to three pounds of fibre, which is used for rope-making. The fibre varies from four to six feet in length, is very tough, and would, it is said, make a superior twine for bagging. It is cut and planted every three years. *Balazier* (*Hilicomea*) is a wild plant, grows on cool soil, and its presence indicates superior land. The blades, which resemble the blades of the plantain, produce the fibre, but the blades grow from the roots of the bush like a pineapple, and they are six to ten feet long. One acre will produce about 10,000 blades, and each blade will produce half an ounce of fibre. It is a coarse fibre, not so strong as the others mentioned, but is useful for door-mats and similar purposes. Cacao (*Theobroma*) is cultivated for its valuable fruit, but the tree, which grows fifteen or twenty feet high, is trimmed annually in the spring of the year, and the branches of each tree thus trimmed will produce half a pound of fibre, which varies from three to five feet in length. It is strong, and is used as rope for making hammocks. *Bois l'ome* (*Guazuma ulmifolia*)

is a straight tree. At a distance of eight or ten feet up the body of the tree, five or six branches shoot out in a circle round it, and from this point to the top of the tree, encircling branches shoot out at the distance of about one foot apart. The lowest circle of branches are the longest, and they shorten as they ascend the tree, causing the tree to assume the shape of a sugar loaf. Both the body and branches produce fibre. It is a straight brown fibre, and very strong, used generally for rope and twine making. Eight hundred trees may be produced to the acre, and after the third year will produce annually from one to two pounds of fibre to the tree. The *Agave Mexicana* grows three or four feet high, and one acre will support 2,500 plants. After three years, each blade will produce half an ounce, or about half a pound to the plant. The crop may be reaped each succeeding year for from twelve to sixteen years without replanting. The plant becomes dry and worthless as soon as it produces a flower, but it rarely produces the flower before twelve years, and usually not before sixteen or twenty years. The plant grows wild on the island, but it is understood to have originally been brought from Mexico. The fibre is three to four feet long, fine, strong, and it is said, would doubtless be good for textile purposes. The *Agave Americana*, or American aloe, grows higher than the *Agave Mexicana*. It varies in height from four to five feet, and the fibre is the same length. It grows abundantly, chiefly near the sea shore, and is understood to be a native of the island. The fibre is coarser than the Mexican agave, but about the same quantity can be produced to the acre. Of the pine-apple (*Ananassa sativa*) only the blade, which is about two feet long, produces fibre. The fibre is strong and fine, and is believed to be well suited for textile manufactures. It is of finer texture than either the American or Mexican agave. *Agave rigida*, or sisal hemp, has lately been introduced into Trinidad. The blades alone, which grow about two and a half to three feet long, are used for fibre. Eight blades, it is said, give an ounce and a half of fibre, and the fibre obtained is about three feet long, strong, coarse, and stiff, suitable, it is believed, for strong ropes and chair-bottoms. An acre will support 2,000 plants of about sixteen blades each, and calculated to produce at each reaping three ounces of fibre to the plant. After three years a crop is reaped annually. Among the fibre-producing plants of Trinidad may be mentioned the *gemove* (*Malachra*), *bois cerp* (*Oreodaphne cernua*); *gumbo mizse*, the pinquine or wild pine-apple; the Spanish needle (*Yucca*); and the *Sansevieria zeylanica*. Consul Peirce states, in conclusion, that he has been informed that there is no machine now in use in the colony which obtains the fibre without destroying the substance of the fibre ribs. The principal machine, if not the only one, now used in Trinidad and Tobago, is arranged for the operator to hold the blade of the plant in his hand, while the machine scrapes out the green and watery substance. The

opinion has been expressed that if a machine could be introduced that would act somewhat on the principle of a cane-mill, in which the cane enters one side and comes out at the other thoroughly crushed and squeezed, a great advantage would be gained over the present practice.

SCENTS AND PERFUMES.

In 1889, 44,608 gallons of perfumed spirits, chiefly eau de Cologne, valued at £87,629, and paying a duty of 10s. 6d. per gallon, were imported into England. Of essential and perfumed oils there were 1,078,277 lbs., valued at £192,340; and of perfumery and articles used therein, 1,367,847 lbs., valued at £139,746. The lavender water distilled at home, the otto of roses, musk, vetiver, Tonquin bean, patchouli, and other perfumes imported, bring up the total to £500,000 sterling. Of orange-flower water, jasmine and neroli oils, citronelle and lemon-grass oils, a great deal are received. There are about 10,000 acres under *Andropogon nardus* grass in Ceylon, and over 5,500,000 ounces of the citronelle oil made from it are shipped. Lemon-grass oil is obtained from other species, *Andropogon citratus* and *A. schananthus*. About 9,000 ounces are shipped from Ceylon. Geranium oil, which is much used to adulterate otto of roses, is distilled in Algeria to the extent of 12,000 lbs.

Otto of roses is chiefly produced in Turkey and India. At Kezanlik and its neighbourhood about 80,000 ounces are made. At Adrianople the yield of an average crop of roses is from 600,000 to 825,000 drachms. It requires about 3,000 lbs. of rose leaves to produce an ounce of otto of roses. The Turkish oil is that most found in our market; but much of the rose oil which England consumes comes also from India, it being largely distilled in the North-West Provinces and the Punjab. From India there was exported last year 12,128 gallons of different essential oils, valued at £20,277. Of this quantity, 3,000 gallons came to the United Kingdom, 1,000 gallons were sent to France, and nearly all the rest went to the east coast of Africa, Arabia, and Egypt. But if we use a great deal of perfumery, we also export perfumed waters, distillates, and articles of perfumery, to the value of about £110,000 a year.

Correspondence.

ECONOMIC DEVELOPMENT OF SIAM.

MR. W. MARTIN WOOD writes:—The motive and chief object of Mr. Gordon's paper, as frankly avowed by him, was to show what railways might

do for Siam and its development in the modern sense, and this he set out most effectively. As Britain is a great iron-master, it is well he should make the most of our chief specialty; but it is worth while to raise the question whether, under the physical conditions of Siam, its "economic development" could not, with less risk, and far more effect on the exploitation of its products, be much more efficiently served by *waterways* than by iron ways. The valley of the Meinan is not so very wide; but, as I understand, the volume of water is permanent and abundant; so that by a good system of canals, such as Continental engineers could devise, the river might be made to serve nearly all the cultivable and accessible productive land of the country. Besides, could not a large navigable canal be easily made eastward to join the Mekhong (part of which I think is in Siamese territory), thereby opening up a far larger sphere of commerce than any railway system in Siam could do? It is scarcely needful to point out that, in proportion to cost, an infinitely greater weight of produce could be brought to Bangkok by smooth transit on water, than by limited and expensive railway haulage—in this case excessively expensive because of lack of cheap fuel.

Mr. Gordon's proposal to construct a capacious harbour for sea-going vessels at the mouth of the river is one that obviously commends itself—more so if joined to Bangkok by a canal; and it is one that might well be undertaken by the Government of Siam.

Here it may be well to remind readers of the often talked of, but still indefinitely postponed, project for a ship canal across the Isthmus of Krau, on the north of the Malacca peninsula. Certain French projectors are understood to have made complete plans for such work long ago. If they have dropped it for lack of funds or support, it might be well worth while for British engineers to take it up. Such channel would not only give direct impetus to the trade and progress of Siam, but would effect a great saving in time and cost for commerce with China and all the Far East.

MODERN FLOUR MILLING.

The paper by Mr. J. Harrison Carter, on "Modern Flour Milling," with the discussion thereon, published in the last number of the Society's *Journal*, gives considerable prominence to the important question of fire risks of flour mills, and contains reflections on fire insurance officials, which are likely to mislead.

Mr. Carter complains that, while charges for fire insurance are made on various machines, no special charge is made for overcrowding, uncleanness, want of daylight, or for naked lights, which defects, he considers, are responsible for more fires in flour mills than all other causes put together. Farther on, Mr.

Carter asserts that the advantage of present purifiers, from an insurance point of view, are incalculable.

Milling engineers who took part in the discussion freely give it as their opinion that fire insurance officials are lamentably ignorant of their business.

These general statements are not calculated to enlighten any one; if, however, milling engineers would furnish detailed information of all occurrences and mishaps in connection with flour milling, having a bearing on the risks of fire, that may come under their notice, they would render great service to all interested in this industry.

The defects referred to by Mr. Carter are not peculiar to flour mills, but are, unfortunately, found in business premises of every kind, where they lead to equally disastrous results.

It would be difficult to define overcrowding, uncleanliness, and want of daylight, with sufficient distinction to form the basis for a special charge; and if some standard on these points could be named, what practical and legal guarantee could an insurance office have that such standard would be constantly maintained? Should either or all of the above defects exist to a serious extent in any important mill, the owner would find great difficulty in obtaining insurances from responsible offices.

The position of artificial lights in flour mills is even more important than their protection; the glass lamps which the latter arrangement implies are liable to collect dust, and may thus cause the very evil it is desired to guard against. Electric light is, without doubt, the safest for flour mills, but this has its own peculiar dangers, and must occasionally be discontinued for repairs, the drawing of boiler fires, &c.; the lights temporarily used while such repairs are in progress will probably involve serious increase of risk, and thus materially discount the advantages electric light is calculated to secure. Portable lights necessary for the examination and repair of the internal and other portions of machines are a source of great danger, and are doubtless responsible for many fires, the causes of which are given as unknown.

One in every fifty of the mills in the United Kingdom using rollers, purifiers, and modern machinery, burn down annually. In view of this fact, it is difficult to admit that present purifiers are of the incalculable advantage, from an insurance point of view, claimed for them by Mr. Carter.

Modern flour mills, from a fire risk point of view, consist of lofty buildings having numerous machines on their several floors; most of these machines are formed with light pine framing and boards, enclosing reels or other appliances clothed with silk gauze or similar fabrics; the different parts of the machines have innumerable bearings, with every variety of mechanical motion; their whole interiors are charged with clouds of highly inflammable particles; and all these machines are connected with each other by numerous spouts and elevators. In such conditions the risk of fire is necessarily very considerable, and should fire occur, it spreads throughout the mill

before extinguishing appliances, although kept in constant readiness, can be brought to bear; even sprinklers have never yet prevented the spread of fire through a flour mill proper, where the arrangements offer such facilities for its rapid extension, and at the same time prevent water reaching the burning material.

JAS. SHEPPARD.

March 9th, 1891.

General Notes.

INDIAN GOVERNMENT PUBLICATIONS.—A list has been issued by the India-office of the Indian Government publications which are on sale at the India-office, and at the Government presses at Calcutta, Madras, and Bombay. These publications are not issued direct to the public by the India-office, but may be obtained through any of the authorised agents, whose names are given at the end of the list. In the future half-yearly lists the prices and dates of publication are to be added. Copies of the list can be obtained from the Registrar and Superintendent of Records at the India-office.

CHICAGO EXHIBITION, 1893.—The Science and Art Department have forwarded to the Society a copy of the regulations with regard to the Customs dues on articles sent to the Chicago Exhibition. All goods intended for exhibition will be admitted free of charge through any port of the United States. It is intended that they shall be valued on arrival at the Exhibition buildings; and at the close of the Exhibition, unless the goods are forthcoming, the duties will have to be paid. Special conditions will be made for loss, deterioration of perishable goods, &c., and also for the consumption of articles as samples. It is not intended that the duty shall be levied, except on goods which are actually entered for consumption in the United States.

BUDAPEST EXHIBITION OF EARTHENWARE.—Information has been received from the Foreign Office, through the Science and Art Department, that supplementary lists of articles open for foreign exhibitors at this Exhibition have been issued. (See *ante* p. 227, Feb. 6, for notice of the forthcoming Exhibition.) According to supplementary arrangements exhibits from foreign countries in the following classes will be admitted:—I. Raw materials for the purposes of the clay industry. II. Unglazed clay wares. III. Glazed clay wares. IV. Porcelain. V. Stoneware. VI. Working materials—tools, machines used in the chosen branches of industry.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock :—

MARCH 18.—F. H. CHEESEWRIGHT, "Harbours, Natural and Artificial." Lord ALFRED CHURCHILL will preside.

APRIL 8.—A. P. LAURIE, "The Durability of Pictures Painted with Oils and Varnishes." W. HOLMAN HUNT will preside.

APRIL 15.—WM. TOPLEY, F.R.S., "The Sources of Petroleum." CLEMENT LE NEVE FOSTER, D.Sc., will preside.

APRIL 22.—SIR GUILFORD MOLESWORTH, K.C.I.E., "Bimetallism."

APRIL 29.—WILLIAM ROBINSON, "The Use of Petroleum in Prime Motors."

Papers for which no dates have been fixed :—

"Fast and Fugitive Dyes." By PROF. J. J. HUMMEL.

"Armenia." By CAPTAIN J. BUCHAN TELFER, R.N.

FOREIGN AND COLONIAL SECTION.

Tuesday evening, at Eight o'clock :—

MARCH 17.—SIR EDWARD N. C. BRADDON, K.C.M.G., Agent-General of the Colony, "Recent Development of Tasmanian Industries."

Tuesday afternoons, at Half-past Four o'clock :—

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Papers for which dates are not yet fixed :—

LEWIS ATKINSON, "The Diamond Fields of South Africa."

C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

WILLIAM WYLDE, C.M.G., "The Opening of Africa."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." The Right Hon. LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 30.—COL. J. O. HASTED, R.E., "The Periar Project." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian

History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MARCH 24.—CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

APRIL 14.—G. T. ROBINSON, F.S.A., "Decorative Plaster Work." WALTER CRANE will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

POPULAR AFTERNOON LECTURES.

Friday afternoons, at half-past 4 o'clock :—

Captain ABNEY, C.B., D.C.L., F.R.S., "The Science of Colour."

March 13.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

LECTURE II.—MARCH 16.—The existence of subsalts of silver—Coloured forms of the haloids—Photosalts—Colloidal organic compounds of silver—Silver albuminate and "gelatino-nitrate"—The principle of emulsification—Other photographic materials—Photo-physical and photo-chemical change—Modification of crystalline form under the influence of light—The action of light on asphalt—Photo-chemical study of iron compounds—Photo-chemical study of mercury and copper salts.

LECTURE III.—MARCH 23.—The action of light on the silver haloids—Accelerators and retarders of photo-chemical decomposition—The invisible products of the action of light on the haloids—Sensitive films—The function of the vehicle in modern emulsions—The invisible effect of light on the haloids—The photographic image—Development and subsequent processes.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 16... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. R. Meldola, "Photographic Chemistry." (Lecture II.)

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. W. Crowder, "Observations made in the Working of Vitriol Chambers." 2. Mr. A. H. Allen, "The Chemistry of Whiskey and Allied Products."

Surveyors, 12, Great George-street, S.W., 8 p.m.
 Mr. Walter Clode, "Some Questions of Law arising out of the Occupation of Houses in Flats."
 Medical, 11, Chandos-street, W., 8½ p.m.
 Asiatic, 22, Albemarle street, W., 4 p.m.
 Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m.
 Dr. Courtney, "The Reality of the Self."
 London Institution, Finsbury-circus, E.C., 6 p.m.
 Dr. C. Meymott Tidy, "What is a Poison?"

TUESDAY, MARCH 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Sir Edward N. C. Braddon, "Recent Development of Tasmanian Industries."
 Royal Institution, Albemarle-street, W., 3 p.m.
 Prof. Victor Horsley, "The Structure and Functions of the Nervous System." (Part I.) "The Spinal Cord and Ganglia."
 Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. John Thornhill Harrison's paper, "The Subterranean Water in the Chalk Formation of the Upper Thames, and its Relation to the Supply of London."
 Statistical, School of Mines, Jermyn-street, S.W., 7½ p.m. The President, Dr. Frederic J. Mouat, "Prison Ethics and Prison Labour."
 Pathological, 20, Hanover-square, W., 8½ p.m.
 Sanitary Institute, 74A, Margaret-street, W., 8 p.m.
 Prof. A. Bostock Hill, "Trade Nuisances."
 Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. A. Smith Woodward, "Note on some Dermal Plates of *Homostens* from the Old Red Sandstone of Caithness." 2. Mr. G. A. Boulenger, "Notes on *Lacerta simonyi*." 3. Mr. W. F. Kirby, "Some Neuroptera Odonata (Dragon-flies) collected by Mr. E. E. Green in Ceylon." 4. Mr. Oldfield Thomas, "Some Antelopes procured by Mr. T. W. H. Clarke in Somali-Land."

WEDNESDAY, MARCH 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. H. Cheesewright, "Harbours, Natural and Artificial."
 Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 o'clock. Annual Meeting. 1. Presidential Address by the Earl of Ravensworth. 2. Lord Brassey, "Future Policy of Warship Building."
 Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. G. J. Symons, "A Contribution to the History of Rain Gauges." 2. Mr. A. W. Clayden, Exhibition of Lantern Slides illustrating Meteorological Phenomena. 3. Exhibition of Rain Gauges, Evaporation Gauges, &c.
 Microscopical, 20, Hanover-square, W., 8 p.m. Mr. T. Charters White, "New Method of Demonstrating Cavities in Dental and Osseous Tissues."
 Archaeological Association, 32, Sackville-street, W., 8 p.m.
 Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Mr. E. Morton Daniel, "Patent Medicines." 2. Mr. P. Jensen, "A few Notes on the Patent-office Library."
 National Indian Association, Westminster Town-hall, S.W., 4 p.m. Mr. James Routledge, "Indian Students and English Influences."
 Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Spring Exhibition.
 Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. Otto Friederici, "Electrical Appliances."
 Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. "Sounding Apparatus, in regard to safe navigation, more especially by the use of the Submarine Sentry."

THURSDAY, MARCH 19... Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 a.m. 1. Mr. J. H. Biles, "Some Recent American Warship Designs for the American Navy." 2. Professor Vivian B. Lewes, "Boiler Deposits." 3. Monsieur M. Marchal, "Study of certain Phenomena of Compression." 7 p.m. Mr. A. F. Yarrow, "Boiler Construction Suitable for withstanding the Strains of Forced Draught."
 Royal, Burlington-house, W., 4½ p.m.
 Antiquaries, Burlington-house, W., 8½ p.m.
 Linnean, Burlington-house, W., 8 p.m. 1. Rev. Hilderic Friend, "Researches on Earthworms of the Genus *Lumbricus*." 2. Mr. W. F. Kirby, "Hemiptera and Heteroptera of Ceylon." 3. Surgeon-Major A. Barclay, "Life History of Two Species of Puccinia."
 Chemical, Burlington-house, W., 8 p.m. 1. Dr. J. H. Gladstone, F.R.S., "The Molecular Refraction and Dispersion of various Substances." 2. Prof. Dunstan and Dr. W. H. Ince, (Part I.), "The Crystalline Alkaloid of *Aconitum Repellens*." 3. Mr. A. E. Tutton, "The Crystallographic Character of Aconitine from *Aconitum Repellens*."
 London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Ernst Pauer, "Originality in Music." (Illustrated.)
 Royal Institution, Albemarle-street, W., 8 p.m. Prof. C. Meymott Tidy, "Modern Chemistry in Relation to Sanitation." (Lecture III.)
 Historical, 11, Chandos-street, W., 8½ p.m.
 Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. 1. "Fourth Report of the Research Committee on Friction: Experiments on the Friction of a Pivot Bearing." 2. Messrs Edward H. Carbutt and Henry Davey, "On recent Trials of Rock Drills."
 FRIDAY, MARCH 20...Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 o'clock. 1. M. Barba, "Recent Improvements in Armour for Vessels." 2. Mr. Thomas Phillips, "The Alteration in Form of Steel Vessels due to different Conditions of Loading." 3. Mr. J. A. Yates, "The Internal Stresses in Steel Plating." 7 p.m. 1. Mr. Thomas Mudd, "Certain Details of Marine Engineering." 2. Mr. C. H. Haswell, "Combined Crank, Crank and Intermediate Shafts for Marine Engines, and their Liability to Fracture." 3. David Joy "An Assistant Cylinder for Marine Engines."
 United Service Institution, Whitehall-yard, 3 p.m.
 Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Victor Horsley, "Hydrophobia."
 Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. A. Wynter Blythe, "Sanitary Law: English, Scotch, and Irish; General Enactments; Public Health Act, 1875; Model Bye-laws, &c."
 Mechanical Engineers, 25, Great George-street, S.W., 8½ p.m. Papers and Discussions continued.
 Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.
 Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. S. U. Pickering, "The Theory of Dissociation into Tons and its Consequences." 2. Mr. J. Swinburne, "Some Points in Electrolysis." 3. Mr. A. L. Selby, "The Variation of Surface Tension with Temperature." 4. Prof. S. P. Thompson, "Magnetic Proof Pieces and Proof Planes."
 SATURDAY, MARCH 14... Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "The Forces of Cohesion." (Lecture VI)
 Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.

Journal of the Society of Arts.

No. 2,000. VOL. XXXIX.

FRIDAY, MARCH 20, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the course on "Photographic Chemistry" was delivered by Professor R. MELDOLA, F.R.S., on Monday evening, 16th inst. Professor Meldola dealt with the various forms of the haloid salts of silver, and exhibited specimens of the so-called photo-salts, the easy preparation of which he demonstrated by preparing a sample of the purple chloride. He also touched on the action of light upon asphalt, and remarked how important it would be if the sensitiveness of asphalt could be increased. He then went on to the photo-chemical study of iron compounds, and concluded by exhibiting a new invention of Mr. Varley, by which an iron compound was stated to be made as sensitive to light as the ordinary gelatino-bromide of silver. Mr. Varley obtained a picture on paper coated with this compound (the nature of which, in view of the patent not being complete, was not explained) by an exposure of a few seconds to gas light.

The lectures will be printed in the *Journal* during the autumn recess.

POPULAR AFTERNOON LECTURES.

CAPTAIN ABNEY, C.B., F.R.S., delivered the fifth and concluding lecture of his course on "The Science of Colour" on Friday afternoon, 6th inst. The subject with which Captain Abney dealt principally was colour-blindness. He described the usual test with coloured

wools, known as Holmgren's test, and gave an instance of a case in which a patch of the retina only being deficient in the colour sense, the patient was able to pass a test with ordinary size skeins of wool, but failed entirely when a similar test was applied by means of small coloured balls.

A vote of thanks was passed to Captain Abney for his valuable course of lectures, on the motion of the CHAIRMAN.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, March 10th; H. LONGDEN in the chair.

The paper read was—

ENAMELS AND ENAMELLING.

By J. STARKIE GARDNER.

By enamel we shall understand, for this evening at least, a preparation of glass fused to metal.

There are several ways of applying the heat which is to fuse the vitreous silicate to the metallic base. The silicate may be applied as a dry powder, or moistened into an adhesive paste, and melted in an oven or kiln, or under a blowpipe. Experience alone dictates the best means of procedure.

There are many kinds of enamel. Those best known are the *cloisonné* and the *champlevé*, which are called inlaid or incrustated enamels; the transparent or *basse-taille*, which is practically a chasing in low relief floated over with a coloured glaze; and the painted enamel, which is simply a painting in enamel colours on a surface of glass fused to copper, and passed through the kiln as pottery. There are many varieties of each, and several of the processes can be combined to decorate a single object.

As the subject is rather a large one to treat within the limits of an hour, only the briefest outlines can be given, and to save time we will take the practical and the historical together. *Cloisonné* is the oldest system, if we except the small dots of white enamel so sparingly used in some of the Greek and the Etruscan jewellery. Mr. Franks leaned to the opinion that the art was unknown to the ancient

Egyptians, who produced a similar effect by bastard or inlaid *cloisonné*, in which the glass was set in, and not fused in the metal cells. There is, however, some enamelled *cloisonné* jewellery of Egyptian character at Berlin and Munich, which was found at Meroe, 800 miles south of Egypt, mingled with objects of late Roman workmanship. It includes bracelets with rich enamelled diapers in dark and light blue, heightened by white and red, the colours being separated by delicate metal fillets.

We next meet with *cloisonné* enamel in a shallow bowl, described by Franks,* in the bottom of which is a sculptured rock crystal bearing the portrait of Khosrau, probably the first, A.D. 531—579. Around the crystal are three rows of circular medallions, bearing rosettes, alternating white and crimson, with green filling in between. The whole of the enamel or glass is ornamented in relief, and has evidently been cast in moulds; the medallions are held by the fillets of gold, like the parts of a painted window, but fused to them. The enamels are here transparent, a variety of *cloisonné* known as *plique à jour*. In the course of some experiments I have had carried out by Mr. Fisher, we have ascertained that *plique à jour* can be done on a large scale. The glass paste can, moreover, be impressed with figures like this dolphin, which is in considerable relief, recalling the paste cameos of ancient Rome. One of the *plaques* was produced on a plaster bed, which has been burnt away; but the more important pieces have been melted on metal plates, from which they have subsequently been detached. These present great richness of colour, and an antique honey-combed appearance, combined with delicacy of outline and other characteristics, quite unattainable by any other process. The *plique à jour* is now being produced in Russia, and in a still more beautiful manner in France, by a talented artist. These results are attained in a different way from mine, however, and seem to be tazzas and goblets of filigree, into which the enamels are very skillfully melted, under the blowpipe. They are, unfortunately, costly.

The art was not lost in the middle ages, for there is a 15th century cup, supposed to be Burgundian, but which has also been considered English, in the Kensington Museum which has some fine piercing, into which the enamel has held while solidifying, as water clings to the meshes of a sieve. We have tried the process

with finely pierced copper plates. Here is a plate immersed in transparent green, and another in which several rich colours are introduced. A cup in *plique à jour* was shown by Francis I. to Cellini, who relates how he endeavoured to explain the manner in which it was produced.

FIG. 1.



STANDING CUP OF SILVER AND ENAMEL FROM THE SOUTH KENSINGTON MUSEUM. (ENGLISH 15TH CENTURY.)

To return to the ordinary *cloisonné*, the process first appears associated with enamels applied to gold, and Mr. Franks suggests that this was because the thin fillets laid on produced the *cloisonné* effect with the greatest economy of metal. It fell into disuse when enamelling became applied to copper. Disregarding doubtful evidence, probably the oldest *cloisonné* enamels, except those from Africa, are found in England and Ireland. Gold filigree jewellery, inlaid with garnets or paste, was produced in all parts of Europe during the 5th to the 8th centuries; and when the inlaid paste has decomposed along the edges, this false *cloisonné* is difficult to tell from the true. Small *cloisonné* enamels seem to occur, set as jewels in the iron crown of Monza, given by Theodolinda, who died in 625; in the reliquary of Sion, given by Altheus, reputed uncle of Charlemagne, dated 790; in the reliquary of Pepin; in the crown, sword,

* Franks, in "Manchester Art Treasures," p. 6.

and gloves of Charlemagne; the patenæ of St. Gauzelin, 922-962; and in many other objects in the 10th century. There is always the possibility, especially in the case of Charlemagne's diadem, that the enamels are of late insertion, and there is no conclusive evidence to be gathered from any of these objects, that the practice of enamelling was carried on in Byzantium prior to the 10th century. The oldest definitely Byzantine enamels appear to be certain reliquaries from Mount Athos, of which there are two in South Kensington Museum, one owned by Lord Zouche being ascribed to the year 969. The first important piece of definite date is, however, the magnificent Pala d'Oro, of Venice, some pieces of which are in our Museum of Practical Geology. It was ordered in 976, but not completed till 1105. This long lapse of time rather militates against the view that the art was perfected so early as the 10th century.

Next in age to the Byzantine work would be placed, probably, that produced at the Monastery of St. Cassian, in Italy, under Abbot Didier, 1058. Numbers of Byzantine workmen must have been dispersed over Italy, and perhaps Germany, under the Iconoclasts. According to Theophilus, the Tuscans excelled in *cloisonné* enamelling; and a specimen of their work exists in the cover of the "Evangel" of Ariberto, Archbishop of Milan in the 11th century.

The origin of enamelling in Germany is generally traced to the marriage of Otho with the Greek Princess Theophanie in 973. The earliest German enamels are probably those at Essen, inscribed with the names of Matilda, Abbess, 974-1013, and Theophanie, Abbess, 1014-1054. The first are said by Darcel to be far better in execution, being probably Byzantine, than the latter, which are of native production. The German work is partly in *cloisonné*, and partly *champlevé*, a mixed system, almost peculiar to Germany, and of which we have a magnificent specimen in the Soltikoff reliquary, dated 1150, at South Kensington. In this work the enamels are shaded. During Abbot Suger's time, 1137-1144, enamellers were fetched from Lorraine to work at St. Denis. Little is known of the history or seat of the enamel industry in Germany, except that inscribed pieces show that it was produced at Cologne and at Verdun.

I had not tried to produce any *cloisonné* enamels until I met Mr. Clement Heaton, who has given the process such extended and

beautiful applications, through the substitution of encaustic and other bodies for those of a glassy nature. He prepared some *cloisonné* plates, which we had filled in with flux and coloured glasses. An angel, by Mr. Fisher, shows that a beautiful effect may be produced by altogether immersing the wires; but, as a rule, they are just kept above the glaze. The outline is drawn on the copper, and the wires bent to it, and attached by a little colourless flux, and the cells are filled in with more of the powdered flux, previously stained by cobalt, copper, &c., to the desired colours. The whole is then fused for a few moments in an oven. The process can be repeated until the cells are all uniformly full, and the work can be polished down to a perfectly level surface, if desired; but in all the experimental enamels I have made I have found it preferable to leave the surfaces with simply the fire-glaze. It is well known that almost the whole of the superb Chinese and Japanese, and the Indian enamels, are produced by the *cloisonné* process, by the use of the blow-pipe. In some classes of Indian enamels, only certain cells are filled in with emerald or sapphire coloured enamel of great brilliancy, the rest being left gold. Occasionally the Chinese did this, as in the beautiful specimen lent us to-night by Mr. Frederick Beer. While the Chinese enamels remain much as they were, the Japanese have completely changed their style more than once; and their highest aim for the moment appears to be the production of great expanses of faultlessly even enamels, without *cloisons*, with some slight and sketchy bird and bamboo, put in with great, if misapplied skill, to represent the careless touches of a brush. Mr. Beer has lent a fine example of this work for exhibition to-night. Within the last two years we have seen the Japanese introduce, and largely use, the *aventurine* glass, for so long the secret of a few families of Venetian workmen. Most spirited attempts to revive the process have been made by Tiffany and Cristofle. Elkington made an attempt, but met with no success, as he appears (from specimens in the Kensington Museum) to have copied the Japanese too closely.

We now pass to the *champlevé*, a process which almost certainly originated in Britain, prior to the Roman occupation. The art subsequently passed to France and Italy, where, judging from the Castellani collection in the British Museum, only very small brooches, &c., were made. Most of them appear to have been glass inlays, partly melted into the cells,

since large use is made of the millefiori or mosaic glass, composed of bundles of slender filaments of different colours, arranged in patterns and fused, and so drawn out that the designs appear most delicately minute. *Champ-levé* next appears in the 11th century, mixed, as we have seen, with *cloisonné*. The number of specimens in existence must be very large, for nearly thirty reliquaries are known in the diocese of Cologne, some of which, as the shrine of the Magi at Cologne, of Nôtre Dame at Aix-la-Chapelle, Saint Servais at Maestricht, &c., are of unusual dimensions. The ordinary German *champ-levé* enamels are characterised by rather rude drawing, with figures of relatively large size, and the use of many colours, as many as eight or nine being found in the same example, some being translucent. They are generally shaded, with the colours passing into each other at times; while the introduction of some *cloisonné* work is very constant. A branch at Maestricht, in the 12th century, is called by the Belgians the *Ecole Liégeois*, but there is nothing to distinguish it. We meet with no specimens of German *champ-levé* after the beginning of the 14th century. There is a small specimen on loan at the South Kensington Museum, representing Gideon and the Fleece, which comprises no less than three blues (azure, turquoise, and cobalt), two greens (apple and beryl), amber, black, yellow, red, white, and a transparent colour known as *lie-de-vin translucide*. The costume of Gideon is either French or English, he being armed, as in the Bayeux tapestry, with conical helmet, spear and banneret. It is curious that a facsimile plate, but without any enamel, was figured in the "Messager des Sciences Historiques," in 1853. In addition to the Soltykoff reliquary, the South Kensington Museum possesses an altar cross from Cologne of the 12th century, a *retable* of the same period, and a triptych of the 13th century, from Alton Towers, in magnificent preservation.

Small enamels were made at Conques in the 12th century, if not much earlier, and towards the end of its third quarter we first hear of Limoges, destined to become the most famous seat of enamel industry. The celebrated grave-plate, at Le Mans, of Geoffrey Plantagenet, father of Henry II., who died in 1151, is specially interesting to us from its early heraldry. One of the earliest-known specimens from the Abbey of Grandmont is at Cluny, and has an inscription in Limousin *patois*; and a ciborium in the Louvre is signed

by a Limoges master. Authentic 12th century specimens are rare, and the vast mass of early Limoges work dates from the 13th century. The objects consist of croziers, missal covers, finger basins or gemellions, pyxes, and reliquaries. These are nearly always decorated with figure-subjects on a ground of deep cobalt blue. Turquoise, green, red, and white are used more sparingly. The backs of the reliquaries, and parts of the other objects that do not give scope for figure decoration, are diapered. The reliquaries are decorated with gold figures on an enamelled ground, as in the Becket reliquary at Sens, or enamelled figures on a gold ground. Sometimes the figures are in relief, and then either plainly gilt or enamelled; one in the Poitiers Museum has mounted knights and angels enamelled in relief. Gems are used, or are omitted. The rarest objects are the "Dove" pyxes, or "Colombes Eucharistiques," discontinued in 1200, only four of which were shown at the Trocadero in 1889.

I may mention, as illustrating the vast wealth that England possesses of such objects, unknown to the public, that I have casually seen two of these doves, within a few months, in the houses of private gentlemen. The grandest efforts of the Limoges enamellers were the tombs and altar fronts, few of which now remain. The tomb of William de Valance (dated 1296) in Westminster Abbey, was made at Limoges. The enamel is almost perfect over the rough wooden effigy, and shows a pillow, surcoat, and shield, emblazoned all over with the arms of Valance and England. It is known that another tomb was made in 1277 for Walter de Merton, Bishop of Rochester. Bronze and enamelled effigies of a son (dated 1247) and brother of St. Louis have been placed in St. Denis, the enamel in which is mainly blue, red only being introduced in the arms of Castille. Drawings of some of the lost Limoges tombs are preserved in the Bodleian. The tomb of Blanche de Champagne is in the Louvre. Prior to the Revolution, there was an entire altar front of Limoges work in the Abbey of Grandmont; and many fine tombs disappeared at the same time. Some are still preserved in Spain. The old *champ-levé* work of Limoges fell into complete disrepute in the 14th century, on account of its monotonous and inferior execution. With it died the art of *champ-levé*, only to be temporarily revived in England during the 17th century, and in Russia, and in a yet more commercial spirit in Paris in our own day. The electrotyped arabesqued clocks

and candlesticks, with turquoise ground, have been familiar objects in shops and stores for the past ten years. I have made small attempts at *châmp-levé* myself, but Mr. Heaton is about to revive it, and to give it an extended application.

A few *châmp-levé* enamels have been produced in Italy and elsewhere, mostly during the 14th century, which made little or no impression on the progress of the art.

The use of translucent enamels was extensively practised by English goldsmiths in all ages, down to the 16th century. In France, their use seems to have come in at the close of the 13th century; and in the 14th we find a few works of great beauty enriched with translucent enamel in Belgium, and Germany as well. The invention of enamels à *basse-taille*, or chasings on gold or silver in low relief, floated with translucent enamels, seems to be due to Italy. The varying thicknesses of enamel thus obtained gave the required light and shade, the faces of the figures being usually covered with the thinnest colourless glaze. John of Pisa, and Duccio of Siena, were using translucent enamels at the end of the 13th century. The celebrated tabernacle of Orvieto, made by Ugolino of Siena, in 1338, is only exposed twice during the year, and no drawing of it exists. Another reliquary, by the same hand, has been figured by Labarte. The taste for these enamels prevailed during the 14th and 15th centuries; and several specimens of Italian work were lithographed in Digby Wyatt's book on "Metal." It is extremely difficult, if not impossible, however, to distinguish those made in Italy from the French and German contemporary specimens. In Cologne Cathedral there is a crozier, and reliquaries at Aix-la-Chapelle, and formerly at Bâle, decorated with translucent enamel. The Kensington Museum possesses a magnificent pastoral staff, German, 1350; an exquisite jewelled and enamelled chalice; and an Italian casket of 1423. There are also a few true *basse-taille* enamels of Italy in the Museum. The *basse-taille* is a most artistic process, and is practised with the greatest success by several of the very high class French silversmiths. I have been able to produce it in an extremely inexpensive and effective way. These dolphins are in *repoussé* copper, afterwards floated in flux stained with copper oxide. There is a cast dolphin, the tin in the alloy having affected the flux in a peculiar manner, and rendered it partially opaque. The sunk parts of the *repoussé* bowl exhibited were enamelled

under the blow-pipe. I have produced a beautiful effect on some small *plâques* by using opaque as well as translucent enamel.

Little time can be devoted to the very large class of painted enamels. In these the metal is entirely covered with the enamel, the preliminary coat being either light or dark, with the details painted on in colours lighter or darker than the ground. We begin to find the process in use towards the end of the 15th century, when the Limoges enamellers were striving to produce the effect of *basse-taille*, by the cheaper process of painting. Towards 1520, the *grisaille* enamels appear on violet-black or cobalt grounds. The effects were heightened by tinsel under transparent stained flux, and by gilding after the enamel was finished. The Venetians had a system, in the 16th century, of decorating beaten copper tazzas, and salvers, entirely covering them with blue enamel, on which were gilded ornaments of arabesques and diapers. A few good painters took up the process at Limoges, but it was one hardly likely to attract the highest order of talent. Like the older *châmp-levé* work, it fell into disfavour, and we learn from Rupin that the last enameller of Limoges died in 1804, without successors to whom he could communicate his secrets. It is sad to reflect that early in the century tons of enamels were melted for the sake of the few ounces of copper they comprised.

The Battersea enamels were the result of a mistaken attempt to compete with decorative pottery on its own lines. Painted enamels are now produced in every respect, as to their technique, equal to those of the past. Indeed, at no previous period could such a ruby *plâque* as that I exhibit, have been produced, and the extensive use of ruby made from gold is a triumph of the French enameller, which dates almost from the last great Exhibition in Paris. Painting on enamel is not much more difficult, I understand, than painting on pottery, but the results are perhaps less certain. Mr. Fisher has made a number of essays for me, having practised the art at South Kensington, where a teacher was engaged from France a few years since, and classes held, until the technical difficulties were mastered. The translucent blues and green we obtained, by making and mixing our enamel and colours from the beginning, are as brilliant as can be, and we further secured an entirely new colour, a rich copper ruby, as well as translucent golden yellows and browns. A visit to Messrs.

Phillips, the jewellers, in Cockspur-street, convinced me that the art is far from dead in England, but relatively it is dormant. The strides that the enamellers in iron have made is but too painfully apparent in the polychromatic advertisements that everywhere meet the eye. With the ample knowledge of *technique* that we now possess, we ought to have no difficulty in re-establishing the industry on an artistic basis. I am glad to say that, at the next meeting of the Applied Art Section of this Society, Mr. Heaton will point out the innumerable ways in which it can be usefully applied; and as his paper and my own are parts of the same theme, I trust the same audience may be here to hear him.

ENGLISH ENAMELLING.

That enamelling has always been an English industry is perhaps known to many present; but no one probably has ever realised the part it has played in the development of the art. So few have collected or regarded English works of art, that we scarcely realise that we possess any; and while all that is best in foreign art is put before the public in elaborate treatises and museums, ours is almost without a literature, and scantily represented in the national collections.

Doubt as we may, whether enamelling was ever practised in the East in pre-Roman times, there is no doubt it was known to the Britons and Gauls. That Britain was actually the first nation on earth to make an extensive use of enamelling on bronze, is a fact that is now beyond the reach of contradiction. If the varied ores of copper and tin were habitually reduced, and mingled, and cast in this country by primitive methods, oxides must often enough have been formed and streaked the crucibles with finely-coloured glazes. The Phœnicians, most perfect masters of glass working, traded extensively with us for tin, if not for copper; and may likely enough, have taught the British how to add to their palettes of vitreous colours. The single drop of blood-red enamel, produced from copper, in the centre of the exquisitely wrought bronze shields found in the Thames, and now in the British Museum, show a high appreciation of art, antedating the Roman invasion. Archæological Transactions abound with descriptions of enamelled buckles and fibulæ, which show no trace whatever of Roman influence, enamelled by the *champ-levé* process in green, yellow, red, and white. There can be no doubt that the oft-quoted passage of Philostratus, written early in the

third century, to the effect that the oceanic barbarians possessed the art of pouring colours on bronze, which they fix and petrify by fire, applied chiefly, if not wholly, to the British.

FIG. 2.*



BROOCH.

British enamels were widely exported, either by wars or barter, and perhaps the finest specimens found their way out of the country as spoils or gifts. Some found in Scandinavia bear no traces of Norse art, and a principal piece, a bowl with laurel border and vandyked base (Fig. 3), has its counterpart from Braughton, near Standon, Herts. That the British, during the Roman occupation, had learnt to make quite important and highly decorated vases, is shown by the celebrated one from the Bartlow Hills, in Essex, ornamented with the ivy, laurel, and vandyke borders, so usual in Romano-British enamels. At this period we find a blue, reported by Prof. Faraday to be from cobalt; as well as the yellow, red, green, and white from tin and copper. The cup from Pymont, in Waldeck, and the gourd-shaped bottle from Istria, have similar ornaments, and show to what distances valuable works of art might travel even in those days. The vase found at La Guierche, near Limoges, is of precisely the same technique and style; and in a vase dredged off the coast of the Pas-de-Calais, we seem to have recovered a similar object, actually wrecked in its transit from Britain. Two small tripod-stands, of classic outline, found at Harwood, in Northumberland, have, the one a festooned design in scarlet on a turquoise ground, and the other a chevron pattern. Equally curious are the *champ-levé* fibulæ in form of a hare, a hen, and a spirited horse, found at Lincoln and in Gloucestershire. On the other hand, the enamel work found among the *débris* of the metal workers' quarter at Bibracete, is of the poorest description, and quite different in character to the decided and artistic ornaments met with in even our own very earliest examples. A glance at the

* Figs. 2 and 3, from Du Chaillu's "Viking Age," have been kindly lent by Mr. Murray.

Castellani collection proves beyond doubt that the taste for enamelled bronze jewellery spread into Italy, but the objects produced were relatively very small, and the continuous use of

millefiori, or Roman mosaic glass, shows that the enamelling practised was of a bastard kind, consisting of a glass inlay, partially used into the cavity.

FIG. 3.



BOWL.

The highly decorative, but unfinished, enamelled *plaque* in the British Museum, found in London, and enamelled in blue, red, yellow, and white, takes us a considerable step further, and is a production of which even mediæval art might be proud. From this, to the ring inscribed Ethelwulf, in blue *champ-levé* enamel on gold, is but a step. To the jewel of Alfred, son of Ethelwulf, is but another step, yet that step comprises the whole advance from the *champ-levé* work of the Celtic Briton, to the *cloisonné* work of the Anglo-Saxon. No piece of *cloisonné*, bearing intrinsic evidence of its date, can compare in antiquity with this simple jewel, inscribed with the words, "Aelfred mec heht gevvr can." But it does not stand alone. We have the exquisite brooch of *cloisonné* enamel found on Dowgate-hill (fig. 4), with its portrait of a royal person, conjectured to be Alfred or his father, with its translucent green and blue tunic attached to each shoulder, its opaque tints for the flesh and hair, and the golden-yellow crown, and pearls, and black enamel rosettes, set in the filigree gold border. And still another brooch, figured by Digby Wyatt, of precisely the same work, and reposing side by side with the last in the gold room of the British Museum. Its beauty is so great that Wyatt described it as

"the most perfect fragment of Byzantine enamel in this country," and it was produced when our art was such that youths were sent by permission of Charlemagne, from France, to acquire the art of illuminating manuscripts at the great monastery of York.

FIG. 4.



BROOCH OF CLOISONNE ENAMEL.

If we turn to Ireland, we shall immediately see how the overwhelming influence of religion, letters, and travel had acted on the Celt, and

refined his nature and his art from relative barbarism into the most intellectual and cultivated of his day. In pre-Christian times we find bronze horns of the same admirable work as the Thames shields, and with the same single spots of red enamel. In Christian times, possibly as early as the 8th century, we have the Ardagh chalice, with three distinct kinds of enamel, all of them showing an amount of thought and delicacy of manipulation which is most remarkable. The first is described by Dr. Sullivan as "round bead, or tabular or arched, enamels of one colour, with a pattern of metal. The second consists of similar enamels of two colours, with a pattern of metal. The third of similar enamels of two colours, without any pattern of metal. The first kind is formed of a head or tubular piece of coloured transparent glass, into the upper surface of which, while in a soft state, was pressed a chambered or *cloisonné* pattern, cut out of a piece of solid silver. The spherical or flat surface was afterwards polished. This kind may be considered to be a peculiar variety of *esmail cloisonné*, the *cloisons* not being, however, made by joining together slips of metal, and soldering the pattern thus formed in a plate of metal, or ground, but by being cut out of a single piece of metal, which was then pressed into the softened surface of the enamel, which rose up and filled the open framework of the pattern. The second kind was made by taking a piece of silver of the proper size and cutting out the pattern, one part entirely, and the other not quite through, so as to form, in the first case, an open framework, and, in the second, little hollows or chambers. This pattern was then pressed into the softened surface of a bead, a flat tabular piece, or an arched piece of translucent blue-coloured glass; the glass filled up the *cloisons*, as in the first kind above described. The little hollows or chambers formed by not cutting the metal quite through, were then filled by a more fusible opaque enamel, which did not come into contact with the translucent or basal enamel. This variety may be considered as a unison of the peculiar kind of *esmail cloisonné*, represented by number one, and of the *esmail en taille d'épargne*, or *esmaux champ-levés*, the basal or translucent glass being much less fusible than the second, or *champ-levé* enamel, which, as has been observed, alone is opaque. The third kind of tabular or arched pieces of translucent glass (coloured blue), on the surface of which was engraved (or impressed), in *in-*

taglio, a design or pattern, which was afterwards filled up with another coloured and opaque enamel. This is an interesting variety of the *esmaux champ-levés*, in which glass is substituted for metal as the base in which the pattern is incised. In this case the translucent glass and opaque enamel are brought into direct contact, and show a considerable amount of skill in producing glasses of different degrees of fusibility." The art was not lost in Ireland, for on the underside of the shrine of St. Moedoc of Ferns (early 12th century work) there is a border of red enamel decorated with squares of blue translucent, and of red and white enamel. On one of the bosses with which this border was studded at intervals is a blue enamelled fylfot on gold ground, surrounded by blue and gold lines. The Lismore crozier (1090-1113) also has bosses of coloured enamel, which seem an inlay of glass upon glass. Enamels were frequently used in early Irish goldsmiths' work, as gems, and the detail is generally very fine, comprising red, blue, green, and yellow. There is a particularly good one in St. Columba's College.

It was necessary to dwell at some length on these Irish enamels, as they supply the link between the oldest Christian enamels found in England and those of the coarser kind belonging to the Roman civilisation. The enamel work was, it may still be, executed by Britons to Anglo-Saxon orders, for the Anglo-Saxon and contemporary European jewellery is merely inlaid with garnets or paste.

We have thus most definite evidence that the art of *cloisonné* and other enamelling was being practised to perfection in England during the 9th century, while we have no such certain evidence that it was practised elsewhere at this date. We might venture the hypothesis that the art was taken to Rome by Ethelwulf and Alfred, both of whom went to Rome in great state. It is curious that the Paliotto, executed about this date, 835, and before we have any record of enamelling at Byzantium, was made by one Wolvinus, an unmistakably Saxon name. A critical re-examination of the gem-like enamels which are found associated with some of the most ancient goldsmiths' work, such as the chalice of St. Remy, at Rheims, and the Limburg reliquary, assumed to be Byzantine in the absence of any other hypothesis, would be very interesting from the Anglo-Celtic point of view.

One of the most beautiful croziers in existence was described by Willement as having

been found in the tomb of Ragenfroi, bishop of Chartres, who died in 950. It is inscribed, "† FRATER WILLELMUS ME FECIT." The artist's name would alone prove that it was not a Byzantine work. The crook is finely diapered all over with a knotted label; towards its widest part the label bears the names of vices and virtues, which are illustrated in the interspaces by the most graceful figures imaginable. The knop bears four exquisite medallions from the life of David, united by a flowing label, on which the narrative, in Leonine verse, is engraved, Goliath is habited in mail, something like a knight of the Bayeux tapestry, but the rest of the figures and the drawing irresistibly recall illustrations to English manuscripts, &c., of the 11th and 12th centuries. The colours used are three shades of blue, white, red, green, and brown. The whole of the drawing and execution has a delicacy and refinement utterly foreign to the work of Limoges or Germany; and we shall see, by comparison with other specimens, that both in arrangement and the abundant employment of Leonine verses and inscriptions, it agrees with the work habitually designed in England. This priceless treasure, once in the Meyrick collection, has been allowed to find its way to Florence.

An important enamel, known as the Bruce bowl, is described by Franks. In its chequered career it has belonged to Malcolm Canmore, and to Mary Queen of Scots, and was, in 1859, in the possession of Mr. Bruce, of Kennet. It was probably the top of a ciborium, and is surmounted by a knop and four leaves, all enamelled. The bowl and cover are decorated with a stem and foliage, forming six medallions on each, inclosing subjects from the Old Testament on the one, and from the New on the other. The figures, as on the Ragenfroi crozier, are gilt, except the Christ, which is in pale lilac enamel, on blue or green grounds. The enamels are vivid in colour, and abruptly shaded. Another priceless bowl belongs to the Earl of Warwick (Fig. 5), and was bought about August, 1717, out of a brazier's shop in London, and passed into the possession of Geo. Holmes, Deputy Record Keeper of the Tower of London. The drawing is much finer than in the Bruce bowl, but we have the same medallions enclosed in rich scroll work, with the figures gilt on blue or green enamel. The foliage, and the upper and lower borders, have been richly enamelled in bright or shaded, and strongly contrasted colours, as red, violet, and white. Over each

subject there is a Leonine verse, as in the Bruce bowl, three of the lines being identical on both. Mr. Franks remarks that all display, delicate erudition, and thought in the choice of the subjects, generally selected from Scripture history, and give a high idea of the perfection to which art had attained. It was impossible, at that date, 1859, so little did we know, comparatively, of the art of our own

FIG. 5.



WARWICK BOWL.

country, to claim them as English work; and being quite distinct from the Byzantine or Limoges work, they were presumed to be German. There are absolutely no enamels of German origin in the smallest degree like them, while the characteristics of the design are met with in English work of every kind, as in the painted 12th century ceiling of the nave of Peterborough Cathedral, the design on Fair Rosamond's ring, &c.

The Bruce horn, which is believed to have

FIG. 6.



PART OF THE BRUCE HORN.

belonged to the nephew of Robert Bruce, who was Regent of Scotland, and died in 1331, affords another beautiful specimen of English enamelling of the same class.

English enamels of the 12th and 13th century

are extremely rare. There is a crozier at Wells in gilt copper with blue enamel, traditionally assigned to Bishop Savaric, and two at St. David's, assigned respectively to Bishop Gervase, 1229, and Thomas Beck, 1293. At St. Peter's, Claypole, Lincolnshire, a fine knob and part of a staff is painted over, and used to support the bookboard of the pulpit.

Whether we may venture to claim the two enamel half-discs in the British Museum, representing Henry of Blois, Bishop of Winchester, produced, according to Franks, between 1139 and 1146, I cannot say, but they do not look like Limoges work, and the word "Anglia" occurs in the inscription. The *chasse* in Hereford Cathedral, and the one belonging to the Society of Antiquaries, both representing the martyrdom of Becket, may be Limoges work. We must remember that the goldsmiths' and other artistic work produced at Ely, Glastonbury, Durham, York, Colchester, and St. Albans, were celebrated from the 11th to the 13th century, the names of a number of the artificers being mentioned by Matthew of Paris and others; and that treasures as vast as those of the Continent were accumulated in England, that of Walsingham Church, in Norfolk, being described as worth £250,000 of our money. Moreover, articles of English enamel were evidently prized on the Continent, for they are always specially mentioned in the French inventories, as the enamelled clasp in that of Duke of Normandy, 1363, and in 1399 the great enamelled gold goblet and ewer, weighing more than six marks, given by Henry IV., King of England, to Charles VI.; while Charles V. took a fine specimen of enamel from England with him. Again, in 1292, we find for the first time five enamellers on the Paris register, one of whom was distinguished as "Richardin l'esmailleur de Londres," with a shop in the Rue des Deschargeurs. If we add to this the fact that the glass windows for St. Ived, Braine, consecrated in 1216, were procured from England, and described by those who saw them as alike remarkable for the beauty of their drawing, and the harmony of their colouring; and that the 13th century windows still remaining in the corona of Trinity Chapel, Canterbury, are unequalled for the skill with which the minute figures are represented, as well as their purity of design, excellence of drawing, and harmonious colours, we shall only wonder that the enamels, which excel in precisely the same characteristics, should not sooner have been claimed as

English work. There is, moreover, most fortunately preserved, one specimen of enamel of the time of Richard II., whose English origin has never been in dispute. I mean the Lynn cup, 15 inches high, which is covered, bowl, stem, foot, and cover, with translucent enamels, most of which are remarkable for their clever drawing, and the quaint costumes represented. It is divided into delicate

FIG 7.



LYNN CUP.

medallions bearing small figures, as in the older specimens, and the colours are grey and red, blue and green and purple. Part of a cup, at All Souls' College, is also entirely covered with translucent enamels, *cloisonné*, as well as *champ-levé*, of the most delicate character. The arms of Navarre and Champagne show that it was produced between 1276 and 1316.

But we have not exhausted the tale of

English enamels, rare and little known as these objects are. The binding of the Bodleian Psalter, in solid silver, is enamelled in the most brilliant blue, orange, green, and violet. The panel represents the Annunciation, with a rich scroll-work border. To the 14th century also belong the celebrated Wykeham crozier, 7 feet high, in silver glit, and of singularly sumptuous work, enamelled with translucent colours, to whose richness it is impossible to do justice. The figure of the kneeling bishop takes the place of the lamb; and it was left by will, dated July 24th, 1403, to New College, Oxford, with the mitre, part of which is also preserved to this day. We may just mention the Fox crozier at Corpus, which is less beautiful, and pass on to the magnificent Limerick crozier, and the mitre, whose enamelled inscription tells us that it was made by "Thomas O'Carty, *artifex faciem* (faciebam)—1418." These are not inferior in taste, elegance, or richness to the Wykeham example. Only four years previously, Catherine of France, then Queen of England, sent the Duke of Brittany a beaker and holy picture of gold. Except a silver 14th century censer, found in Whitesea Mere, the only other ecclesiastical object of this date that I have met with is the small silver diptych for the pocket, each leaf of which was divided into eight compartments, with figure subjects, covered with translucent enamel, and of great artistic merit. The enamels were worn from the outside, but remained perfect on the inside faces. It was said to have been found in Essex, and formed part of the Arundel collection in 1795. There is an object in the collection at Kensington which is almost its counterpart.

Though jewellers' and goldsmiths' work was enamelled with translucent colours, really in *basse taille*, during the 14th century, in England, as abroad, the opaque *champ-levé* enamels were not abandoned for some time. There are enamelled shields on the tombs of Edward III. and Richard II., and shields and belt on that of the Black Prince. The sword of Edward III., in the possession of the Comte de Mailly, has on one side of the pommel the enamelled shield of France, old style, and on the other the quarterings of England and Aragon. A casket made for a De Valence (1290-1300), in the Kensington Museum, in gilt copper, is diapered with the arms of England, Angoulême, Valence of Pembroke, and Dreux of Brittany and Brabant. There is also a small shrine in the Museum, with red enamel, representing St. George and the

FIG. 8.



THE LIMERICK CROZIER.

Dragon. and a rude processional crucifix with blue enamel; perhaps like the one found on the Dalton estate, near Lancaster, which had medallions and panels of blue enamel. We must not forget the exquisitely enamelled armorial bearings on the hearse and tomb in the Beauchamp Chapel at Warwick (1439), which shows an opaque emerald green that I have never seen elsewhere.

In the Garter plates at Windsor we have, as Mr. St. John Hope said, "a series of memorials extending over a period of upwards of 500 years, and forming such a storehouse of ancient and modern historical armoury as exists nowhere else in Europe." The early ones are "resplendent with enamelled armorial ensigns." The oldest is that of Sir Ralph Barrett, in three pieces, which are exquisitely enamelled, and date between 1368-1390. The plate of Sir W. Hungerford, who died in 1421, presents a rare example of dead black enamel, and those of Sir John Grey and Sir Thomas Beaufort introduce a shining black. There are, in all, 108 examples earlier than the year 1500, among the most beautiful being those bearing the arms of Portugal and Burgundy, and of Sir Hugh Courtenay and the Duke of Buckingham. These most valuable specimens are scarcely preserved with due regard to their artistic importance, and were frequently shifted. A very interesting one of Sir William Parr, Marquis of Northampton, 1552, who attended Henry VIII. as esquire at the Field of the Cloth of Gold, was apparently removed and broken when he was attainted of high treason, and is now in the British Museum. South Kensington possesses the Garter plate of Wentworth, Earl of Strafford, and a small plate with the arms of "Maister Clarencius," 1554.

A few English chalices and patens have escaped destruction, notwithstanding the searching pains and penalties their preservation entailed. Thus there are two at Nettlecombe, Somerset, two at Cliffe, near Rochester, and others at Leominster, West Drayton, and Corpus and Trinity Colleges, Oxford, all with blue enamel, and of the 15th or early 16th centuries: a pair of candlesticks of the same date, and also with blue *châmp-levé* enamel, is at Ashbury Church. The English love for enamels, during the 13th to the 16th centuries, is indicated in the extensive use made of monumental brasses, which we may suppose were only not enamelled on account of the difficulty of applying the process to such large objects. Several that are coloured show the intention. Thus, that of the oldest known

brass, Sir John D'Aubernoun (1277) has an azure shield. Colour is used in the brasses of Sir John Foxley, *temp.* Ed. III., at Bray Church, and Sir Hugh Hastings, Elsyng Church. There is red drapery in John Field's brass at Standon, 1474; and red and blue drapery in that of Sir John Say, 1473, at Broxbourne. In three the colours are numerous, namely, Sir William Vernon's, 1407, at Broxbourne, in which we have black, red, white and blue; the Earl of Essex, Easton, 1483, purple, red, two blues, and white; and Sir William Molineux's, Saffron, Lancashire, white, blue, green, and black.

In the Mazer bowels (of which Mr. St. John Hope records incredible numbers to have been in use, as at Canterbury, 182; Durham, 49; Westminster, 40; Battle, 32; &c.), we frequently meet with enamelled armorial bearings, as in those at All Souls and Pembroke Colleges, Oxford, and others in the possession of City companies. Use is also made of enamel, chiefly blue, in the beautiful standing cups and salts of the 15th century, such as those at New, Corpus, and All Souls, Oxford, and Christ's College, Cambridge; and in the beautiful Leigh cup, belonging to the Mercers' Company (Fig. 9); and the coronation spoon in the regalia. Half a century later, the goldsmiths had wholly ceased to introduce enamel into their work, though it was never entirely abandoned by the jeweller. Indeed, one of the most exquisite objects in the Kensington Museum is the large jewel, made about 1580, enamelled with arabesques, scrolls, and flowers on a black ground, including a transparent and peculiar treatment of the white. It is further set with diamonds and rubies, and contains inside the miniature portrait of Queen Elizabeth. English watches and snuff-boxes, like those in the Guelph Exhibition, and the beautiful watch by Dobson, of London, presented by the King to the Countess of Monteth in 1675, the 18th century pedometer, and the turquoise-blue on silver Queen Anne candlesticks, show that the art of enamelling had never entirely departed from us.

It only remains to notice the brief, but interesting, revival of *châmp-levé* enamelling under Elizabeth or James I. It was of a rough description; and I have only seen it applied to such objects as fire-dogs, candlesticks, &c. The British and South Kensington Museums each possess a pair of candlesticks; and there are fire-dogs at Drayton-house and Haddon-hall. The enamel appears to have been on brass, ungilt, and the colours were

crude and opaque : plum, yellow, blue, white, and apple green.

The history of the revival of painted enamels at Battersea is so well known that it is unnecessary to more than allude to it. It was established in 1750 by Janssen, and carried on

FIG. 9.



THE GRACE CUP OF THE MERCERS' COMPANY'S.

at York-house, Battersea. A rival, George Brett, had an establishment at Bilston, in Staffordshire. The revival seems to have been an attempt to compete with pottery, which it

closely imitated, and the scheme was but ill-judged.

The sketch I have ventured to offer of the history of enamelling in England, though necessarily brief and incomplete, will at least show that our art deserves something more than the contemptuous dismissal it receives at the hands of foreign writers, and the singular neglect with which it has been treated by ourselves. Perhaps many specimens are still preserved, unknown and unrecorded, in private hands. It is to be hoped that we shall never again miss the opportunity of acquiring them for our national museums should they come into the market, where, notwithstanding the praiseworthy efforts recently made at South Kensington, in the direction of acquiring such important examples as Sir Paul Pindar's house, and the panelled room from Sizergh Castle, in Westmoreland, English art is all too poorly represented.

The paper was illustrated by a series of framed photographs of famous enamels, and an electrotype copy of the "Legh Cup" of the Mercers' Company, from the South Kensington Museum, lent by the Science and Art Department; some enamels lent by Frederick Beer, Esq.; and some books lent by Messrs. Batsford.

DISCUSSION.

Mr. ROBBINS said he had discovered a new process, which he proposed to call fresco enamelling. It was a material which could be used either as paint or enamel. He had brought a specimen of a Sienna colour. It could be used in pottery, fresco, or concrete, and also as a gloss.

The CHAIRMAN said this hardly came within the scope of the paper, which was confined to enamelling.

Mr. ROBBINS added that he had taken out a patent for *cloisonné* work many years ago.

Mr. H. B. WHEATLEY said that one of the most interesting points in Mr. Gardner's very full and beautifully illustrated paper was the description of work in Britain at a very early period. It was well known that the Celts were an artistic people; and the early Irish work in many directions was widely known; but it would be new to many to hear that this enamel work was done in Britain before the time of the Roman occupation. It was also interesting to find that the work of the Celts was so quickly taken up by the Saxons when they arrived here, because though the Celts were generally acknowledged to be an artistic people, the Saxons were not always credited with similar powers. It was

very important that English art work should be investigated and explained by those competent to do so; for unfortunately Englishmen had been very neglectful of the history of the arts in their own country, while foreigners had been very industrious. When a foreigner set to work to write the history of any art, he naturally went to the countries he described for an account of the special work of those countries, and as Englishmen had done very little in the past to illustrate the work of their ancestors, it was not at all strange that foreigners in writing their elaborate histories had often neglected the work of the English. It was to be hoped that before long we should have a really complete account of English arts, and the way in which they had thriven. Various instances had been given in that room. Mr. Weale, for instance, in showing various specimens of old leather bindings, had brought out the fact that in the 12th century some of the finest designs were those made in England; and they might certainly feel proud that artists in enamelling had gone out from England to teach the art to other nations of Europe.

Mr. ALEXANDER P. TROTTER suggested that it would be interesting to others, besides himself, if Mr. Gardner would give a little more information as to the method of enamelling. He understood that only gold, silver, and copper would receive enamel, and he had been surprised to learn that the firing could be done with the Fletcher furnace, having been under the impression that it was a lengthy operation. He should be very glad to know what the enamel was; he understood it was a kind of glass, but did not know how it was applied, or whether, in fact, this was one of the arts which could be practised by an amateur. One mode of forming the *cloisons* had occurred to him a few months ago, which perhaps might be worth considering. There was a process used for producing book illustrations, in which a thin layer of wax was spread on a surface of copper; the design was then drawn with a tracing point through the wax, and it was afterwards electrotyped. That produced a very good copper surface, with the lines coming up to a plane. It occurred to him that the reverse process might be adopted, the copper being deposited on the face of the copperplate on which the lines were traced, thus building up little cells, in which the enamel might be placed. That would appear to be a process which could be carried on by an artist, although, to a certain extent, mechanical.

Mr. CLEMENT HEATON said the process just described was perfectly practicable. When he read his paper on *cloisonné* enamel he would show two or three specimens produced in that way.

The CHAIRMAN, in proposing a vote of thanks to Mr. Gardner, said the work shown by that gentleman, in which he had been assisted by Mr. Fisher, was most interesting as a modern revival of this art,

and in particular the *plique à jour* seemed a most beautiful application of the method, and certainly seemed to justify the suggestions he had made with regard to it. There was beauty of surface and of reflected light, whilst it had also the power of transmitting light. There were no doubt possibilities for it therefore which could hardly yet be realised. He had been very much interested in Mr. Gardner's account of English enamelling. Whenever a Frenchman wrote a book about art he always made everything French, and practically chose all French examples, and we had been too apt to overlook our own things, and had not really collected the information we might have about many things done in England. There were several arts for which we were famous in old times; illumination, for instance, it was well known, was done better here in the 9th and 10th centuries than anywhere; and the English embroidery went all over the world, some very fine specimens being preserved in Rome. There was one point of contact between these arts and that with which Mr. Gardner had been dealing. He had always held that the English understood colour better than most people, and had once seen it stated that those who lived by the sea and on the sea knew more about colour than those who lived inland. Certainly, looking at our paintings, we understood colour as well as any nation, and better than most at present. This would seem to bear out a good deal of what Mr. Gardner had said about enamelling, for the whole beauty of enamel was that it became practically a mosaic colour, and illumination and embroidery also depended on the same principles.

The vote of thanks having been carried unanimously,

Mr. STARKIE GARDNER, in reply, said enamel was glass, but not ordinary glass. It was specially prepared for the purpose. Any amateur might take up the art; in truth, what he had shown was really amateur work, having been done with no particular object, except the desire to see what could be made of it. Messrs. Powell, and Mr. Lechertier Barbe, of Regent-street, supplied glass or colours for enamel. It had to be pounded very fine, and then spread, either wet or dry, on the copper. It was then put into the furnace, and you had to watch it, until it got white hot, and the instant it fused it must be taken out. Anyone who was an expert in cooking would be good at enamel, as a great part of the success depended on knowing when it was "done to a turn." It was very desirable, indeed, that amateurs should take up this art, because amateurs did not mind how many times they failed; but, to a business man, it was a loss of time to make experiments over and over again, and get results which were of no commercial value. As yet, he had been able to make but very little use of the art, though in the Norwich altar rails, and in some screens, he had introduced a little of it. At present he was only feeling his way, but he was very hopeful

about the glass he had shown, because there were certainly qualities about it which could not be got in any other glass; not only the honeycomb, but the *cloisons* being of bright metal, threw the light into it, and instead of the glass being dullest round the metal, as in the case of lead, it was there at its brightest. The electrotype method would be very useful no doubt. He had exhibited one example of enamelled electrotype, which showed there was nothing in the composition of the copper thrown down which was adverse to the process; on the contrary, it was very pure copper, and produced very good results. With regard to the mode of producing fine work, such as vases, &c., he held the enamel was put in wet, so as to hold in its place, and then fused with a blowpipe. It was not all done at once, but cell after cell was placed under the blowpipe, until the whole was finished. When done, it was very rough; towards the bottom of the cells the colour protruded, but towards the top the cells were empty, and they had to be filled up again and again until they were level, and then they were rubbed down with emery or pumice, a very laborious process. In all his *cloisonné* work he had been satisfied to leave the cells unfilled, with the fire glaze on them; nothing had been polished. He ought to say that it was Mr. Fisher who had really done the work, for he had not time himself to devote to the practical part of it. He would conclude by calling attention to the photographs of enamels lent by South Kensington Museum, and also to the reproduction in electrotype of the 16th century Leigh Cup, which belonged to the Mercers' Company. It was a very beautiful specimen of the goldsmiths' work of the period. Some of the most famous enamels were represented in these coloured photographs.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 18, 1891; Lord ALFRED S. CHURCHILL, Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Gregory, William John, 1, St. John's-terrace, Weymouth.

Jenkin, Charles Frewen, Waltham Abbey, Essex.

McMullen, James F., South-mall, Cork.

Ove, Cecil, 20, Park-road, Harlesden, N.W.

Owen, Edward Humphrey, J.P., F.S.A., Ty Coch, near Carnarvon.

Peach, Charles Stanley, 8, John-street, Adelphi, W.C.

Pocklington, Frederick A., Oldham-place, Renshaw-street, Liverpool.

Sully, Herbert Thomas, Oriel-house, Springfield, Chelmsford.

Thomas, William Lussn, 190, Strand, W.C.

Wain, William James Carruthers, 25, College-hill, E.C.

The following candidates were balloted for, and duly elected members of the Society:—

Cooke, William George, 35, Walbrook, E.C., and Spencer-hill, Wimbledon, Surrey.

Dagger, John Henry Josiah, Endon, Stoke-on-Trent. Gimingham, Edward Alfred, Stamford-house, North-umberland-park, Tottenham, Middlesex.

The paper read was—

HARBOURS, NATURAL & ARTIFICIAL.

BY F. H. CHEESEWRIGHT.

I know of no more absorbing subject in the whole range of the science of engineering than that of the construction of harbours, rendered necessary where the coast line of a country does not afford, by inlets, shelter for its ships.

It is my intention, by means of this paper, to lay before you drawings and charts of some of the most notable of the natural harbours, as well as artificially made harbours, and give such explanations as I consider necessary for your information. There is a considerable amount of danger in dealing with the subject in the form of a short paper, inasmuch as it is one that could easily occupy a great deal more time than I intend to give to it here. I, therefore, have carefully made a selection of such artificial and natural harbours as would commend themselves, in several ways, to your notice, as being historical, and as showing, in some instances, the difficulties engineers have to overcome, and the way, and at what cost of time and money, this was accomplished. I intend commencing from the earliest date until the present time, and leave you to form your own deductions as to how far the science of harbour engineering has progressed.

The importance of the subject admits of no denial; and we find, from the earliest ages, that nations holding command of the sea were generally the most powerful, and studied with the greatest care the art of preserving and improving their harbours, to protect the ships whilst at anchor.

As an early example, mention may be made of the Phœnicians, who, from only possessing a narrow strip of barren land along the coast of Syria, became the most wealthy and greatest

of nations, and were only subdued by Alexander, after a great struggle, and by the help of, it may be said, the whole world.

Again the Greeks, by their command of the sea, maintained their independence with a mere handful of men against the millions of Xerxes.

The Carthaginians made head against and almost conquered the mighty Romans, who only recovered their ascendancy and ultimately overwhelmed their formidable adversary by acquiring command of the ocean. And, although the Romans were naturally averse to the sea and the pursuits of commerce, yet feeling that the preservation of their empire depended on their maritime superiority, they devoted the greatest care and attention to the perfection of their fleets and harbours, as the magnificent remains in Italy, and other places I shall have occasion to mention, afford ample testimony. These works prove that the ancients had made considerable progress both in the theory and practice of marine architecture.

After the fall of the Roman Empire, the whole civilised world became enveloped in darkness; and it was not until trade and commerce began to revive, and the ocean was again covered with numerous fleets, as well for war as for merchandise, that the necessity for providing for them against storms became apparent.

Then it was that the rival republics of Genoa and Venice perceived the necessity of improving their harbours, in order to protect and facilitate the commerce from which they derived their wealth, power, and greatness, as well as to enable them to extend their conquests.

Hence arose the magnificent moles of Genoa, and the still more extraordinary works of the port of Venice. France now began to devote her energies to the subject, and the entrances to the ports of Havre, Dieppe, Calais, Boulogne, and Dunkirk were improved, by adopting the system of confining the mouths of the streams which formed these harbours by jetties or groynes, and thus giving them a proper direction at their points of junction with the sea, by damming up their water and discharging them through sluices at low water, so that the increased velocity and force of the current or scour thus created might remove any accumulation of sand or shingle to which the harbours on the north of France are subject.

Sir John Rennie, in the preface to his "Theory, Practice, and Construction of British and Foreign Harbours, 1854," says:—

"The great extent of commerce in every part of the world, the countless fleets of shipping, which constantly traverse the ocean in all directions, the immense number of valuable lives and vast amount of property involved, render it imperatively necessary upon all maritime nations to provide safe and convenient harbours."

I propose to deal first with natural harbours.

Some parts of the British coasts, as well as the coasts of other countries, are amply provided with natural bays or creeks, while Ireland and the west coast of Scotland are also plentifully supplied with excellent deep water bays and anchorages, but, on the east and south-west shores of Britain, there are but few natural harbours.

A natural harbour may be defined as a bay, recess, or inlet of the sea, or the mouth of a river, which affords good anchorage and a safe station for ships. The great requisites (adequate depth both of entrance and interior area being assumed) are shelter from wave violence, good holding for anchors, and accessibility at all times. More than one entrance, with different exposures to the wind, is desirable, but seldom attained, even in purely artificial harbours. To ensure shelter, it is necessary that the communications with the ocean should be as nearly as possible reduced to a channel or entrance of adequate width, *i.e.*, that the waters of the harbour be, in expressive nautical phrase, "landlocked," and that the entrance be sufficiently wide and the water deep enough to allow vessels of any tonnage to enter at any state of the tide—a desideratum rarely met with.

The first natural harbour I shall direct your attention to is that of Rio de Janeiro, or January River, as having the most beautiful scenery, and being perfectly safe as an anchorage.

RIO DE JANEIRO.

This harbour has been pictured and praised ever since it was discovered, and will be while ships and commerce last. Its acknowledged rivals, San Francisco and Constantinople, can never boast of greater natural advantages than these: a clear approach, an unobstructed entrance, wide enough but not too wide, with fifty square miles of anchorage ground within; and more for light draught vessels. Not a tenth part of the space is used now, and ships have room enough and to spare.

I have been with matter-of-fact and phlegmatic men, who grew enthusiastic when they

passed the sentinel sugar-loaf rock, and saw this splendid bay for the first time.

It is not alone the mountains, those are strange and grand rather than beautiful, but the rocky points, the picturesque side bays, the green hills and islands, the bye-places and glens. Away beyond the city the blue water stretches almost to the Organ mountains, land of purple romance, where the jagged rocks are all mellowed and dissolved in the soft haze, and you see nothing but outline, with the finger-like Dedo de Deus at one end of the range. Some of these peaks are 6,000 feet high.

FIG. 1.



HARBOUR AT RIO DE JANEIRO.

Rocks, by no means insignificant, are on either side. There is the conical sugar-loaf at the entrance of the bay, a mass of 1,200 feet high. Beyond the city is a huge cluster, with the Corcovado and Syrica rising above it, further back the Gavea and Tres Irmaos; across the bay other clusters not so high, but everywhere with abrupt hills and precipices of the purple-brown gneiss. Even the water is not free from these peaks; there are rocky islands here and there, and some of them are crowned with buildings, forts, naval store-

houses, and convents. The old monks must have chosen these sites for picturesque effect.

There is no limit to the beauties of this bay. You go sailing along the shores, and every headland and nook is a delight, with nodding and flowering shrubs. Then there is the shipping, which an artist like Turner would have delighted in.

Ships are picturesque everywhere, but in Rio Harbour they are supremely so. I know not if it be the limpid water, or the background of hazy mountains, or an indescribable something in the air, but there are no other ships like these, not even on the Hudson, where the sloops and schooners are all enchanted. There are monitors, expensive toys of the Brazilian Government, which does not need them all, and gun-boats and war steamers, English ships, French, Portuguese, German; rarely one that carries the American flag, though many belong to American merchants, and are commanded by American masters.

KING GEORGE'S SOUND AND PRINCESS ROYAL HARBOUR.

These form the most south-west portion of Western Australia.

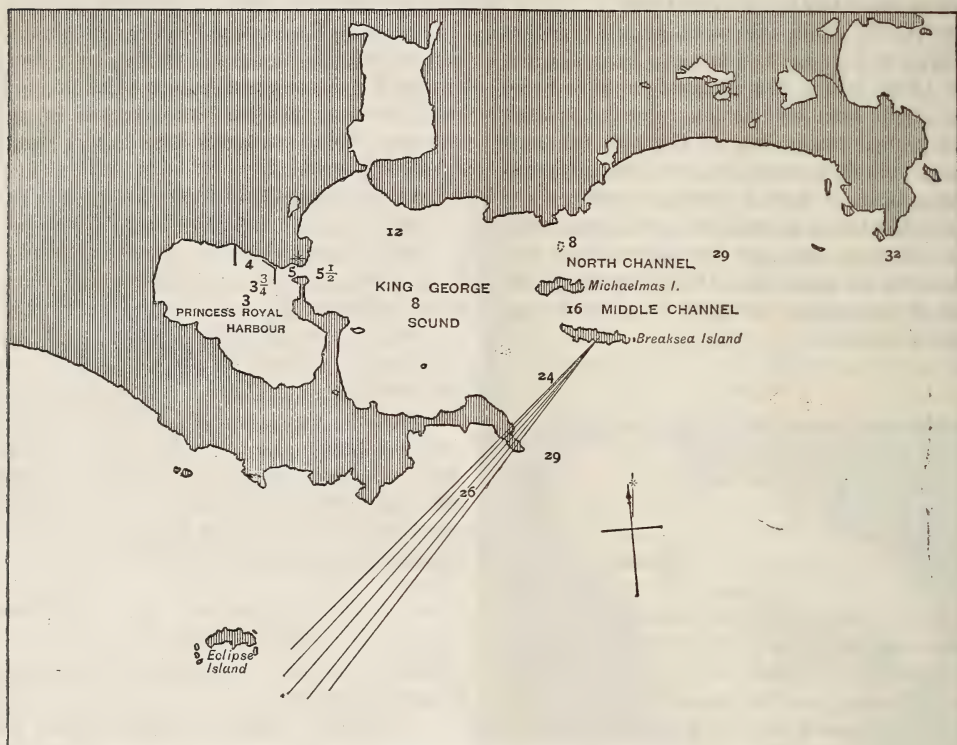
The entrance to King George's Sound lies between Bald Head and Herald Point, at 5 miles north by east from it; and is divided into three channels by Breaksea and Michaelmas Islands. The Sound is about 5 miles wide, north and south, and 5 miles deep, with average depths of 10 to 5 fathoms sand. On the south side of the Sound there is a deep 2 miles long, north and south, and 1 mile broad, having 11 to 20 fathoms, with 7 to 10 fathoms close around.

Princess Royal Harbour is the most convenient of the inner ports of King George's Sound. The entrance, which is about a quarter of a mile wide, lies between Possession and King Points. Its depth in the Fairway Channel is about 25 feet at low water spring tides. The harbour is $4\frac{1}{2}$ miles long, north-west and south-east, and about 2 miles wide; is very shoaly at its west and southern sides, the available portion, for vessels drawing more than 3 or 9 feet, being about 2 miles square.

The harbour here is considered by all authorities almost perfect, and it will not be very long before it is thoroughly fortified, and turned into a great port for war vessels.

It was first used by whalers in the earliest days of the colony; traces of their residence here can be seen now, some of the pathways being made of whales' bones.

FIG. 2.



PRINCESS ROYAL HARBOUR.

PORT JACKSON.

It seems strange that Port Jackson was not visited or explored by Captain Cook. It was seen only at the distance of between two or three miles from the coast. Had any good fortune conducted him into the harbour, he

would have found it much more worthy of his attention, as a seaman, than Botany Bay, in which he passed a week. Governor Philip, the first governor who landed at Port Jackson with the earliest settlers (convicts), pronounced it to be a harbour in extent and security

FIG. 3.



PORT JACKSON.

superior to any he had ever seen, and the most experienced navigators who were with him fully concurred in that opinion. From an entrance not two miles across, Port Jackson gradually extends into a noble and capacious basin, having water sufficient for the largest vessels afloat, and space to accommodate with perfect security any number that could be assembled. It runs in a westerly direction about thirteen miles into the land, and contains not less than 100 small coves or inlets, formed by narrow necks of land, whose projections afford admirable shelter from all winds. Sydney Cove lies on the south side of the harbour, between five or six miles from the entrance. The necks of land that form the coves are mostly covered with timber, yet so rocky that it is not easy to comprehend how the trees find nourishment. But the soil between the rocks is very good, and into those places the principal roots have found their way. Sydney, the capital of New South Wales, is built on the side of one of its bays. Its streets are narrow and tortuous.

Port Jackson, independently of being the port of the metropolis of New South Wales, is justly extolled as the most commodious and secure harbour on the east coast of Australia, and perhaps the finest in the world, and although vessels have sometimes been wrecked in attempting to enter, these disasters, in most cases, may be attributed rather to want of judgment and common prudence than to any real difficulty in making or entering the port. The characteristic features of the coast to the northward and southward of Port Jackson assume different aspects; for although North Head with its immediate vicinity presents a high, table-topped, precipitous appearance, yet the high, undulating hills, thickly covered with trees, which rise from the coast farther to the northward, are strikingly in contrast with the sterile, table-topped cliffs that extend to the southward of the port; and would, even if the lighthouse did not figure conspicuously, point out whether the land seen is to the northward or southward of the entrance of Port Jackson.

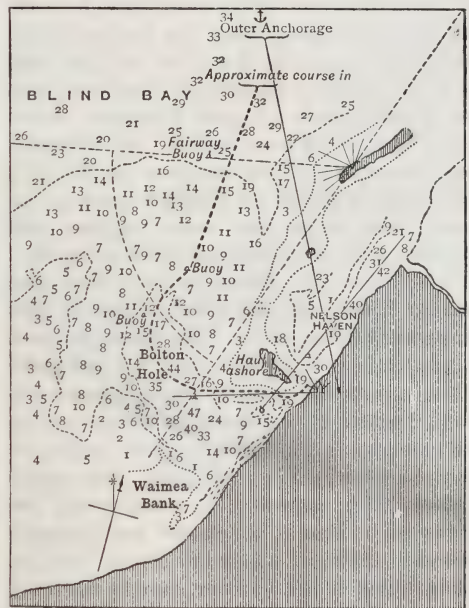
Port Jackson is $1\frac{3}{4}$ miles wide between Outer North and South Heads, but the narrowest part, or what may be considered the actual entrance, lies between Inner North and South Heads, where it is little more than three-quarters of a mile across from cliff to cliff, but this breadth is reduced by a rocky spit on each side to barely three-quarters of a mile. The entrance is clear of dangers, and the

soundings are regular, the depth in mid-channel being 17 fathoms sand. Although there is a depth of 9 to 12 fathoms within a cable of the northern shore, the sea generally rolls in and breaks heavily upon the cliff. The Sound is that part of Port Jackson immediately within the entrance, which branches off into Spring Cove and north and middle harbour. Although the Sound occupies an area of $1\frac{1}{2}$ square miles, with regular soundings in 8 and 9 fathoms, it is too exposed to the ocean swell to afford safe anchorage except with off-shore winds.

NELSON, NEW ZEALAND.

The harbour of Nelson is safe, but small, and difficult of access to large sailing vessels. It owes its foundation to a most singular "boulder bank," which extends eight miles along the coast, forming a natural dam, be-

FIG. 4.



HARBOUR AT NELSON, NEW ZEALAND.

hind which there is a narrow and shallow arm of the sea, which grows deeper at its southern extremity, where it communicates with Blind Bay, and here forms the harbour. The entrance to the harbour is between the southern extremity of the "boulder bank" and the mainland, but is narrowed so much by the Arrow Rock (a rock rising in the middle of it) that the navigable channel is only fifty yards wide. Owing to the extremely swift current of the tide in this narrow channel, and its shallowness, larger vessels can pass in and out only

at high water, and are, moreover, obliged to watch the tide in coming and going. These unfavourable circumstances would greatly hinder navigation but for the excellent anchoring places outside the harbour, which, by the sheltered situation of Blind Bay, are safe in almost any kind of weather. During north-westerly gales, the neighbouring Croixelles harbour offers a perfectly safe place of refuge. The "boulder bank" is one of the natural curiosities of New Zealand. It consists of rounded pebbles or boulders. In time of high water, a large portion of it is under water; at low water it is dry throughout its whole length.

The largest and heaviest boulders are towards the sea-side, on the harbour side the boulders grow smaller; and at a point close by the entrance to the harbour they are so small that vessels there can drive on to the strand without any damage, thus using the place as a natural dry dock, in consequence of the great difference of the water level, between ebb and flow (spring tides rise fourteen feet). The boulders consist of all one and the same kind of syenite, containing blackish-green horn-blends, flesh-coloured feld-spar, and a small quantity of iron pyrites. On following the narrow bank from north to south, it is easily observed that the boulders towards the north grow larger and more angular, and originate from a precipitous bluff of syenite, called "Mackay's Knob," which abuts upon the sea a little beyond Drumduam, the residence of Mr. Mackay. The fragments constantly falling from the cliffs are gradually rolled towards the south by the heavy northerly swell, combined with a strong current of the sea, passing, in time of springtide, with considerable velocity along the coast. The reason of their being deposited on the existing line seems to be that a submarine reef probably underlies them, of which the Arrow Rock, in the entrance of the harbour, may be regarded as the southern termination. The "boulder bank" in front of Nelson is a fine study for the geologist.

PORT PHILIP.

Port Philip is another very extensive natural harbour, being 30 miles from east to west, and about 32 miles north to south. The entrance is very shoaly and difficult to navigate in certain winds. Melbourne is situated on its north shore, and Geelong on the west.

There are other natural harbours existing in New Zealand; for instance, those of Auckland,

Wellington, and Massacre Bay, or Golden Bay, as it is now called; all of which may take rank with the finest to be found in any part of the world, whether in regard to their accessibility, extent of shelter, or quality of anchorage. But I think I have given sufficient information for the purposes of this paper. I could have included Constantinople and San Francisco as worthy of mention, also Cork and other places.

It will be seen, from the examples of natural harbours I have shown, how few countries possess them; and where shipping is the principal support of a nation's greatness, the necessity must occur of constructing harbours or artificial places of refuge. The subject is one of the greatest importance to us, as well as to other countries, every winter's lists of shipwrecks and loss of life reminds us how much nature has left for skill and science to accomplish.

I now proceed to the consideration of artificial harbours.

For the most complete body of evidence regarding the ports of Great Britain, I cannot do better than refer you to the volumes of reports by the Tidal Commission, for the completion of which the world is indebted to Captain Washington, the present hydrographer to the Admiralty.

In the formation of a harbour, the first thing to be done is to erect a breakwater, or, in other words, to construct an artificial barrier destined to break the force of the waves.

And here let me call attention to the fact, that there is absolutely no advance upon the method adopted by the ancients; for it was easy to imagine the man of those early days throwing stones into the water to create a barrier, so that his dug-out might ride in safety. Throwing stones is the system of the present day; no alteration, no improvement or advance in any way, if we except the use of Portland cement. This material has certainly assisted the engineers of our time in raising high monuments of their skill, which might have otherwise been impossible. But the majority of these costly structures are built on a tumble stone foundation, as at first used by the ignorant man of ages ago.

Among primitive works, the piers of the ancient Piræus and of Rhodes may be denominated breakwaters; as also similar modern structures, projected from the shore, and called piers or moles. But the term breakwater has of late been considered as more peculiarly appropriate to large insulated aggregations of

FIG. 5.



HARBOUR AT PORT PHILIP.

stone, whether of regular masonry or sunk promiscuously in rough masses, so placed as to form an artificial promontory or island across the mouth of an open roadstead. This, by obstructing and breaking the waves of the sea, converts a dangerous anchorage into a safe and commodious harbour for the reception of ships of war and merchandise.

In this sense of the term, the breakwater at Cherbourg was the first work entitled to the name, and it remains still the greatest.

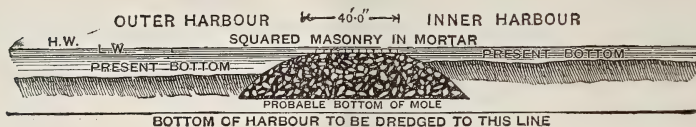
FAMAGOUSTA.

This ancient mole is formed of rubble stone thrown into the sea, each stone weighing between two and three hundredweight. That portion of it which rises above the water is topped with a layer of square-hewn stones, bedded and jointed in mortar. These covering stones are about three feet long, and eighteen inches wide. The capping is almost completely destroyed, having been gradually swept away, in the course of long years,

FIG. 6.

FAMAGOUSTA

SECTION OF ANCIENT MOLE



through the continual action of the waves. Much of the *débris* has been swept towards the entrance of the harbour, which it has, consequently, narrowed.

ALEXANDRIA.

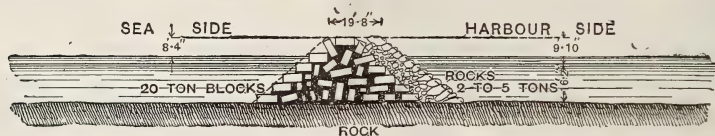
The ancient mole of Alexandria has been

utilised as the basis of the modern breakwater. The modern breakwater was begun in 1870, and finished in two years. In addition to the fact that the groundwork of it had already been laid, this rapidity of construction was largely due to forced labour employed upon it, and there being no tide to contend against.

FIG. 7.

ALEXANDRIA

SECTION OF BREAKWATER



MARSEILLES.

The Marseilles breakwater (begun in 1845 and finished in 1881) consists also of a *pierre perdu* foundation, which is faced seaward with blocks of concrete averaging a greater weight than those at Alexandria; the foundation supporting a superstructure of masonry. The total length of the breakwater is 11,930 feet, its width is 59 feet, in a depth of water from $6\frac{1}{2}$ to 12 fathoms. Some portions of this structure cost £75 11s. per lineal foot, but that part which lies opposite the Lazaret and Arene

basins cost up to £109 14s. per lineal foot. This portion runs into a depth of $55\frac{3}{4}$ feet of water.

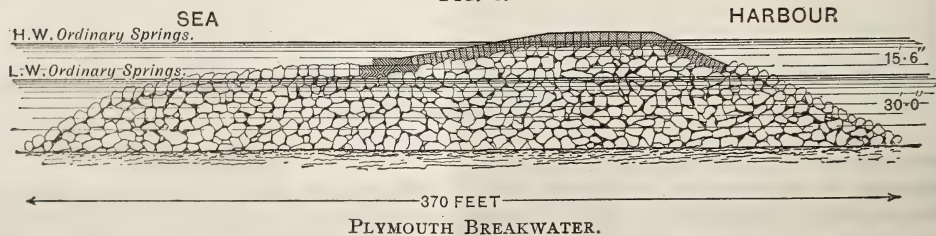
ALGIERS.

Harbours protected by rubble mound and concrete-block breakwater are at Algiers, Port Said, and Biarritz.

PLYMOUTH.

Plymouth Breakwater is isolated in the middle of the Sound, having half a mile of

FIG. 8.



channel on either side of it. It runs direct east and west for 1,000 yards, and then at the wings deflects north at an angle of 120 degrees. The wings are each 350 yards long. It stands 5 feet above the level of the highest spring tide, and has a base of 120 yards. The average height is 14 feet; total length, 1,700

yards, and cost about £1,700,000. The cost of maintenance is £5,000 a year.

PORTLAND.

Portland Breakwater is of a double character, consisting of an outer and inner structure. The inner breakwater is 1,700 feet in length, the

outer 6,400 feet. This is another instance of the tumble stone foundation and concrete superstructure. It was begun in 1847, yet the slopes do not appear to have become properly consolidated, for they suffer continually between high and low water levels. During a single gale, 3,000 tons of stone have been known to be displaced.

ALDERNEY.

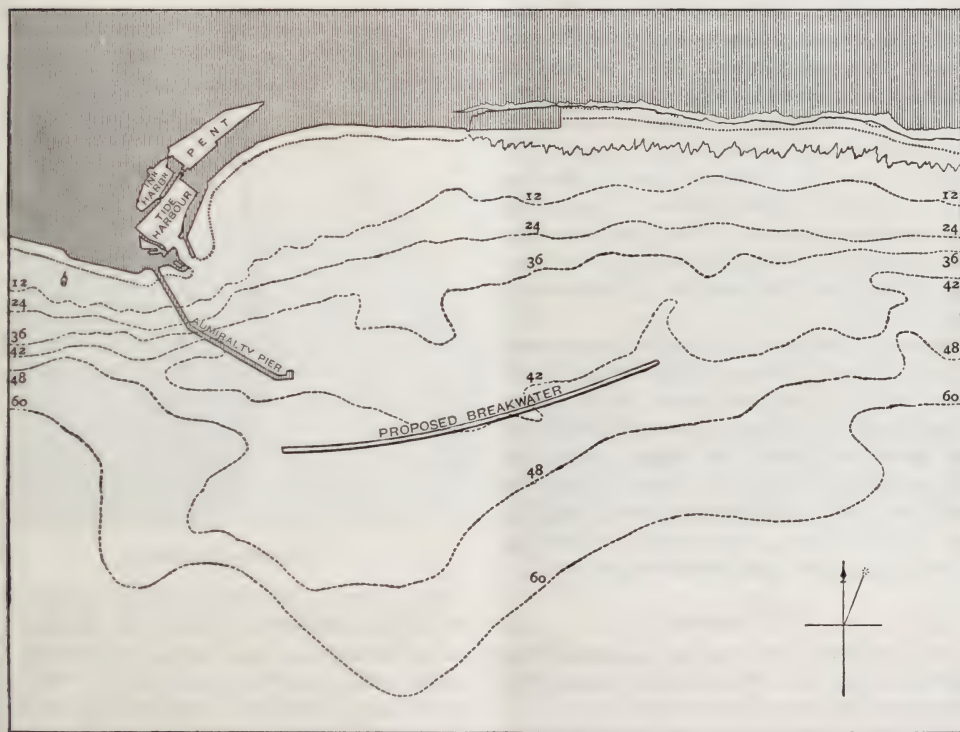
This harbour is protected by a rubble mound and a superstructure founded below water. Depth of water from 21 feet to 34 feet at outer end. The harbour works were commenced in 1847, modified in 1849, again in 1856, and afterwards in 1858. The western breakwater only was carried out to a length of 4,380 feet. The actual cost up to the period of completion

in 1864 was £235 per lineal foot. Cost of repairs of breaches, from 1873 to 1883, £52,850. Depth, extreme, 133 feet.

This breakwater was constructed strongly in its upper and monolithic works; the large masonry blocks forming the outer wall being tied or dowelled together with huge bolts of gun metal, while the rubble and dry masonry base is continually wearing away (see cause of failure at Wick and Arklow).

To a select committee of the House of Commons, Session 1872, on the harbour and fortifications of Alderney, Sir Andrew Clarke, R.E., reported that the cost of Alderney had been £300,000 less than that of Plymouth Breakwater, which was being maintained at a cost of £5,000 or £6,000 a year, and he did not think that Alderney was likely to cost more.

FIG. 9.



DOVER PIER AND PROPOSED BREAKWATER.

DOVER.

It has been proposed from time to time during the last fifty years to build a breakwater and make a harbour of refuge at Dover, but this is still in abeyance from the immense difficulties, and the extreme cost of building a suitable structure in deep water, as proposed, partly from the want of suitable material in the

neighbourhood, but mainly from the great cost of preparing foundations for a suitable superstructure, and the known difficulties attending them.

In the spring of 1845, the Admiralty applied to Messrs. Cubitt, Dennison, Rendel, Rennie, Veitch, Vignolles, and Walker, to make a report, plans, and estimates for enlarging and

improving Dover Harbour, upon the extended scale of 500 acres, as proposed by the Commission in 1844.

As the general plan and extent had been determined by the Admiralty, the difference in the plans proposed by the last-mentioned engineers, consisted in the position and mode of forming the entrance and executing the works. The estimates varied from £1,100,000 to £5,000,000. The latter sum, if ever the work is carried out to the extent proposed, will probably be the cost. These plans and reports were published by Parliament in 1846.

The total cost of the Admiralty Pier is stated to have been £693,077. A sum of £22,827 has been paid, in addition to the above, for repairs of damage done by storm, in 1877 and following years. The whole cost has been defrayed by Parliamentary grant.

The engineers originally were Messrs. Walker and Co., afterwards Messrs. McLean and Stileman, and, subsequently, Mr. Edward Druce, who had formerly acted as resident engineer under the above gentlemen.

It is a stone pier, in good condition, in a maximum depth of water of 45 feet at low-water spring tide, and has no bar or shoaling at the entrance. This pier has a base of 92 feet, in order to obtain a clear roadway of 30 feet in width. The sectional area is 4,736 square feet, and the cost was £360 per foot run.

Notwithstanding the cost and care bestowed upon this work, it is said that it has shown signs of failure at the base, from causes similar to those in every case exhibited where the structure consists of either masonry or concrete blocks, laid on a loose bottom, and built or put together under water, with the assistance of divers, and without cementing, dowelling, or otherwise connecting them.

TYNEMOUTH.

At Tynemouth, we see how destructive an agency is the sea, when acting against the rubble mound form of breakwater.

The breakwaters at Tynemouth are perhaps unexampled monuments of engineering skill, neither intellect, patience, nor money having been husbanded in their production. Here, again, the superstructure is practically faultless, the weak point being the rubble mound. The superstructure is composed of concrete blocks, of a unique form, made on shore, and thoroughly well aired before being lowered and set in their proper places by divers. This is, as well may be supposed, a very costly process ;

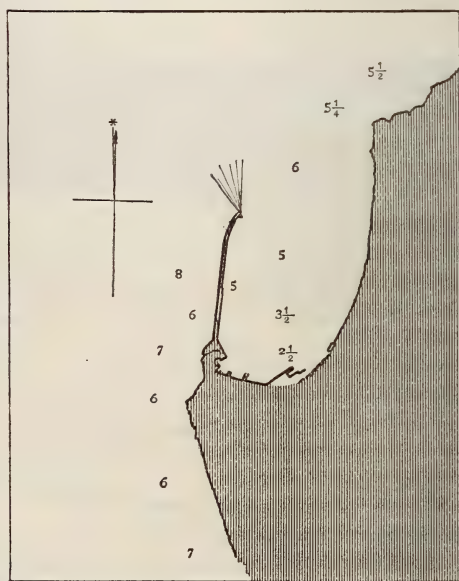
but it has the advantage of being successful, so far as itself is concerned. But, unfortunately, the rubble mound, although considerably more than thirty years have elapsed since it was begun, still suffers materially during the continuance of heavy gales.

This breakwater has been more than thirty-five years in the course of construction, and is not yet finished. The cost of it is enormous.

COLOMBO.

The breakwater at Colombo, which was begun in 1875, is a very fine instance of the use of Portland cement concrete. Here, again, the foundation consists of tumble stone, or *pierre perdue*, the superstructure composed of large concrete

FIG. 10.



COLOMBO HARBOUR.

blocks, varying from 16 to 33 tons in weight. A special difficulty attending the erection of these works was, that all operations had to cease during the "monsoon season," that is, from May to October. The greatest amount of work that it was possible to do upon it, in any one month, was that done in January, 1880, when it was increased by the addition of 154 feet. As the width of the wall at the base is 26 feet, and only 24 at the top, Colombo may be considered an example of an almost vertical breakwater, the greatest desideratum in all marine structures. The composition of the concrete used at Colombo was six parts of broken stone, two parts of sea-sand, and one part of Portland cement.

The total length of the breakwater is 1,150 feet, and its depth is 40 feet. The average cost was £170 per lineal foot.

CHERBOURG.

It was for a long period a favourite project of the French Government to establish a great maritime port in this quarter of the kingdom, in order to counterbalance in some measure the great naval station at Portsmouth, situated on the opposite side of the channel, and the whole coast had been frequently surveyed and examined by the most celebrated engineers for that purpose, and reports and schemes were prepared and devised.

In 1769, however, the celebrated mole or *digue* of Cherbourg commenced by erecting wooden cones filled with stones, after the designs of M. de Cessart.

The cones failed, and in 1777, M. de la Brétonnière, a distinguished naval officer, proposed a plan to construct a detached breakwater, 12,792 feet long, having three openings, viz., one in the centre, and one at each end. These breakwaters he proposed to make by sinking the hulls of vessels filled with stones, in order to form an incline or base for the work in the first instance (similar to the plan which had been adopted at La Rochelle, by Cardinal Richelieu, in the year 1692), and then to cover

FIG. 11.—CHERBOURG BREAKWATER.



the hulls of the vessels with loose angular blocks of rubble stone, or *pierre perdue*, so as to form one continued breakwater.

He proposed this plan of commencing the work, because he was fearful that the undercurrents and waves during storms were so strong, that it would be impossible for the rubble to lie without some expedient of the kind, to bind it together in the first instance.

The objections made to the plan of M. de la Brétonnière were, first, that it would require a greater number of vessels than France could furnish in ten years; secondly, that there would be a great difficulty in getting a sufficient number of workmen; thirdly, that although the plan had succeeded very well at La Rochelle, where there were only 5 to 6 feet

at low water, at Cherbourg they had 40 feet, and in some places more; and as the moles at La Rochelle were attached to the shore, the difficulties there were comparatively trifling to those that would have to be encountered at Cherbourg, where each length of breakwater would be isolated; fourthly, that the upper part of the breakwater would be so much exposed that it would not withstand the shock of the waves; fifthly, that it would not be high enough to give sufficient protection to the shipping within.

The authorities then adopted the plan of dropping a mass of loose rubble into the water, to find its own slope for the base, and *béton* and masonry for the superstructure, which system was carried on with considerable variations

until it was finished in 1853, the total cost amounting to £2,600,000, and nearly eighty-six years were spent in its construction.

It will be readily seen, from an inspection of the various plans of harbours, that the breakwater at Cherbourg is one of the largest marine works ever undertaken, and that it has not been exceeded, as regards the extent of area sheltered, by any more recent works.

Alexandria breakwater approached it in length, and the matchless jetties at Galveston and Charleston are longer; but, considering the solid nature of the work, the batteries it supports, and the period of its construction, it remains a monument of engineering skill and perseverance.

It does not, however, equal in depth, or in section, several other breakwaters, but it furnishes a perfect type of a breakwater formed on a rubble mound with a superstructure founded at low water.

HOLYHEAD.

The breakwater at Holyhead is another example of the rubble-base foundation, with a superstructure of masonry in large blocks, set in lime, and springing from low water level on the harbour side of the mound.

The breakwater has an average depth of 40 feet, and extends into the sea to a maximum depth of 55 feet. It was begun in 1849, and finished in 1873, costing £1,285,000. The total amount of stone used in the construction of this great work has been estimated at 7,000,000 tons. The cost was about £163 10s. per lineal foot.

With the exception of a place at the extremity of the breakwater, it has stood remarkably well, and has cost but an insignificant sum for repairs; but at the end the mound is not quite stable, and tends to travel round the head. Various methods have been adopted to check this tendency, and finally the curious plan was hit upon of placing old chains, weighing 1,000 tons, in coils along the foreshore; this effectually kept the foreshore from shifting, and at the same time offered no solid face for the action of the waves. This end has suffered considerably at various times, repairs to it still going on, to make good recent damage.

WICK.

In Scotland, Wick is one of the most notable examples of a rubble base with block superstructure. This has been one of the most unfortunate erections of modern times, gale

after gale having played havoc with it. In 1868, the outer portion of the structure was seriously damaged in some places, the rubble base being washed down to about 15 feet below low water.

In 1869, the damage had been repaired, and the work reconstructed in cement, when in 1870, during another storm, 380 feet of it was seriously damaged, and again, in 1872, further mischief was done.

ABERDEEN.

The breakwater at Aberdeen was begun in 1870, and finished in three years; its length is 1,050 feet, and is 35 feet wide at the head of the roadway.

The following is a good description of this breakwater, and the injuries it has received.

The landward end, for 500 feet in length towards the sea, had been covered with a thin layer of stones and sand. Of course the sand was cleared away in order to secure a solid foundation before the works were proceeded with. The manner in which the natural inequalities of the foundation were overcome was by levelling up with a deposit of concrete in small bags, on which blocks of Portland cement were built without being cemented.

These blocks, weighing from 10 to 20 tons, were carried up to a uniform level of 4 feet 9 inches above low water spring tides, except at the seaward end, where they were terminated at 9 inches above low water of spring tides. The blocks are composed of 1 measure of Portland cement, 4 measures of pit-sand, and 5 measures of stones. The concrete superstructure, 18 feet in height, was built over the blocks in frames *in situ*, a large number of blocks being incorporated with it. The superstructure is composed of 1 measure of Portland cement, 3 measures of pit-sand, and 5 measures of stone or shingle. An apron of concrete, deposited in bags, lies at the bottom, along a part of the sea or eastern side of the foundation. It commences about 600 feet from the shore, or about 100 feet from the rock foundation, is then carried round the head of the breakwater, and returned along the breakwater, wooden piles being driven 18 feet apart. Each pile is 2 feet in diameter, and passes through the whole depth of the work. The piles are stepped into iron shoes at the foundation, and, where they pass through the substructure, are surrounded by blocks, moulded to the form of the piles, the junction of the blocks being formed at the middle of the pile. The upper foundation

courses of blocks have sustained damage along the whole length of the breakwater on the sea face, and along a part of the harbour face. The holes excavated in the upper courses have hitherto been repaired at low water spring tides, by filling them up with small bags of concrete, and finishing the surface with a facing of Portland cement mortar. These patches have stood well, with the exception of the repairs at a point of 500 feet from the commencement of the breakwater. The breach at this point was further repaired during the summer of last year. These repairs, however, again gave way in the winter of 1890; and the breach was enlarged by successive storms from the north-east to dimensions noted in reports of 6th February, 10th March, and 18th May. The survey made on the 6th February showed the hole to be 22 feet in length, or 3 feet into the breakwater. The survey of the 10th March showed an increase to 72 feet in length, by a depth varying from 4 to 12 feet, with part of the inner row of blocks removed; and on the 18th May this breach formed a cavern 90 feet in length, 12 feet deep, and 23 feet into the breakwater. On examination of the breach by divers, the foundation of small bags of concrete, on which the blocks rested, was found to be removed from under the blocks at each end of the breach.

The superstructure was also damaged on the sea face, close to the lighthouse tower, a breach being formed 54 feet long by 23 feet deep, and about 4 feet into the breakwater. At a point on the sea face, 100 feet landward from the tower, another breach was made, extending partly into the base of the structure and the upper course of blocks. The blocks composing the substructure are chipped and abraded on the sea face, especially near the level of low water. The piles, where they pass through the superstructure, have been eaten away by the sea worm (*Limnoria terebrans*), leaving spaces 2 feet diameter between the blocks. The cost of the repairs was estimated at £17,000.

DELAWARE BAY.

In the year 1828, a commission appointed by the American Government recommended the construction of a breakwater in Delaware Bay. The work was required, from the fact that from New York Harbour to the mouth of Chesapeake Bay, there was no good place of shelter along the coast for vessels exposed to easterly gales. The entrance to Delaware Bay, on the south side, was judged the most

advantageous point for constructing a harbour of refuge, though open to the most dangerous gales from the Atlantic, and those across the water of Delaware Bay from the north-east by the north, round to the west. The place is also exposed to the fields of ice that are brought down by the ebb tide during the winter. The plan of the breakwater was consequently designed to guard against dangers from these different directions. It consisted first of a straight mole, 1,203 yards long, in five to six fathoms of water, the sea slopes being curved after the form assumed by the breakwater at Cherbourg. The work was commenced in 1829, under the direction of Mr. Strickland; and in 1834 it was so far advanced that vessels found protection behind it. The stone used in this work was obtained from a variety of sources: some trap rock from the Palisades in the Hudson River; greenstones, from the northern part of Delaware; and gneiss, from different quarries in the same state. These rocks, though averaging a weight of 175 lbs. to the cubic foot, were insufficient to withstand the action of the sea in the course of the construction of the moles. During the winter season, those upon the surface of the work were more or less displaced, and a large block seven tons weight was moved 18 feet to the inner slope of the ice breaker, down which it was lost. At the same time, about 200 tons of other heavy stone, which had been thoroughly wedged and compacted together, was torn up, and swept over to the inner side. In the United States, there have also been constructed breakwaters of considerable magnitude upon the great northern lakes, for the protection of harbours, as at Buffalo.

RELATIVE ECONOMIC VALUES OF DIFFERENT DESIGNS FOR BREAKWATERS.

I have collected the following cost of different breakwaters from the Minutes of the Institution of Civil Engineers and other sources:—

Name of Break-water.	Depth of water (in fathoms) at low water.	Cost per lineal yard.	Remarks.
Joliette, Marseilles..	5 to 6	£ 225	No rubble.
Algiers	6 to 10½	366	All large.
Holyhead	3 to 9	489	Beton.
Marseilles.....	5 to 9	328	Blocks.
Portland	8 to 10	348 to 360	Convicts.
Alderney	3 to 22	705	Labour.
Dover.....	1 to 7	1,080	.....
Plymouth	6½ to 7½	600	.....

Having thus briefly reviewed some of the most notable of breakwaters forming harbours, it is now my duty to call your attention to the invention of John Lewthwaite, which claims to overcome most of the defects that have been found to exist in the methods that I have brought before your notice.

Theoretically it overcomes every difficulty that has hitherto stood in the way of the construction of effective breakwaters or sea walls.

Its real value can of course only be tested by experience, which very shortly we shall have—putting it to a practical test—as it is already adopted for some large works on the west coast, which will be begun as soon as the necessary capital for the construction has been raised.

The main difficulties hitherto experienced may be summed up in :—

1. Faulty foundations.
2. Absence of vertical line for sea front.
3. Want of continuity.
4. Great length of time required for construction.
5. Enormous cost.

We have seen that the tumble stone foundations have serious disadvantages ; (1) they require a great number of years to consolidate ; (2) they cover a great extent of sea bottom, and are consequently liable to encroach upon the seaway into the harbour, and (3) they assist the waves in destroying their own superstructure.

In elucidation of the last remark (3), it should be stated that scientific men are now all agreed that waves act with less energy upon a vertical than upon a sloping wall. In the case of the vertical wall, the wave acts only by means of its statical pressure, but when hurled upon a long slope it gains a great amount of progressive motion, and, consequently, great percussive force. The result is that the whole weight of the water multiplied by the rate at which it is travelling, would be the measure of its force exerted upon the wall erected at or near the termination of the slope.

The second difficulty, absence of vertical line, has to a certain extent been dealt with already. It is now universally admitted that the great desideratum in breakwaters is the vertical wall, rising direct from the sea bottom. This has been nearly attained at Dover, Colombo, and elsewhere with beneficial results ; at Dover and Tynemouth, at an enormous outlay of time and money, since all the course beneath low water has had to be set by divers, a system of working than

which no more expensive one has yet been invented.

As regards the third difficulty—want of continuity, it may, without exaggeration, be fairly said that, there is not one single artificial breakwater the whole world round, which possesses this very important quality ; a study of the plans will bear this out. Even Portland, that may be described as one of the finest in the world, suffers from the defect, for we have seen that sometimes in one gale as much as 3,000 tons of it have been swept away. Various methods have been adopted to add continually, as much as possible, to the component parts of a breakwater ; at Alderney and Wick we have found that huge bolts of gun metal and iron were employed for binding together the large blocks of masonry, but all the ingenuity displayed has not yet succeeded in producing a really continuous and satisfactory work, and failure in a greater or less degree has been the result.

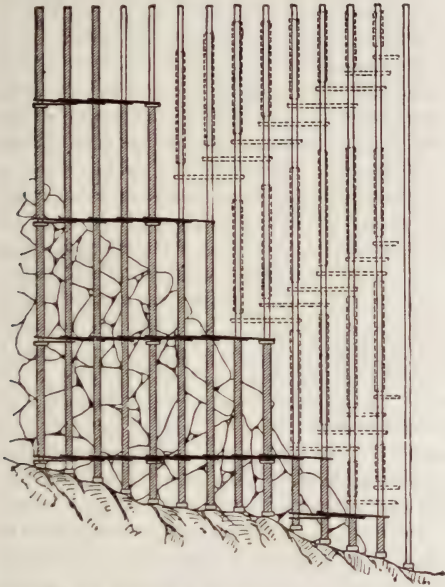
Coming to the fourth difficulty—great length of time required for construction—Cherbourg is an example of the enormous lapse of time required, under the talus system, to produce a breakwater approaching effectiveness or perfection. In other cases, where a fair amount of efficiency has been obtained in a comparatively short space of time, it has been at a proportionately high expenditure of money.

This brings us to the final difficulty in the way of breakwater construction—its enormous cost. A breakwater erected under any of the present recognised systems of construction, taking, say 20 years to construct, might cost the sum of £2,000 to £5,000 a year to maintain it in repair.

In order to overcome the difficulties that have been enumerated during the course of this paper, Mr. John Lewthwaite invented the system which is shown in the models before you. This system is known as “ John Lewthwaite’s Patent Cable Breakwater ; ” and I think you will agree with me that a very fair (I shall not say perfect, as time alone will prove that), attempt has been made to overcome the difficulties which have hitherto baffled the skill and ingenuity of the most accomplished engineers. In Mr. Lewthwaite’s system, the nature of the sea bottom is no bar to the successful erection of a breakwater of any magnitude. Let the bottom be uneven or rocky, let it be even of clay, sand, or mud, the construction will be in no way retarded or hindered. As to supplying that most desired of all things in breakwater and sea building, vertical wall, a very

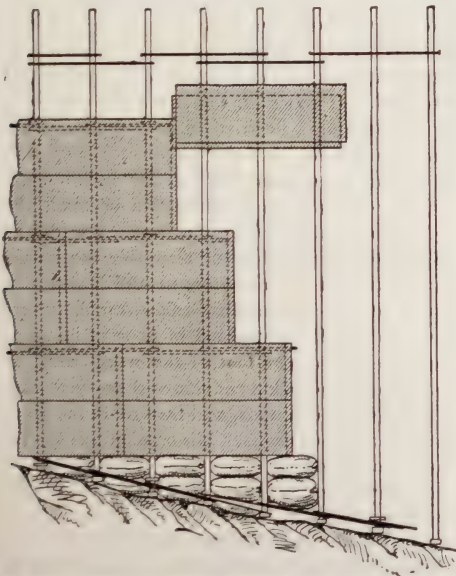
short inspection of the models will satisfy the most captious that such a result is attained. As regards perfect continuity, and making the structure one whole, the way in which these models show the ties which bind the front and back walls together will speak for themselves. A breakwater constructed on this plan becomes, in fact, a monolith.

FIG. 12.



OPEN WORK SYSTEM FIXED ON UNEVEN ROCKY BOTTOM.

FIG. 13.



METHOD OF ADAPTING THE CONCRETE BLOCKS TO UNEVEN ROCKY BOTTOM.

It is calculated that the time taken to erect a work upon this system will prove the shortest on record; and moreover, as once the necessary material is at hand, the greatest rapidity can be used in running out the work. The engineers in charge can select their own time for active operations, collecting during rough weather a large amount of all the necessary materials, which can be put together so soon as there is a prospect of a few weeks' continuing fine weather. By way of giving some idea of the rapidity with which works on the Lewthwaite system could be carried out, it may be stated that breakwaters of equal magnitude to those at Cherbourg and Plymouth could be started and finished in two or three years. And as very little skilled labour is required, and the system can adapt itself to whatever materials lie at hand, its cost may be reckoned at about one-tenth that of any other system.

Having now gone over the subject of my paper in a way that I hope has been satisfactory, I feel constrained to finish here, although I have been obliged to leave out many examples of the science of engineering in respect to harbour construction for want of time. Sir John Rennie, in his great work on harbour construction, published in 1854, and already referred to, does not neglect to advise marine engineers that, "if they cannot find the information they need in any written treatise on marine works, their best course would be to travel the world, visit foreign parts, and gain experience from works in progress." This would seem reasonable if Sir John had been able to point out the parts of the world in which better information was to be obtained. There is no part of the world where marine works are being carried out that can add to the knowledge which is already possessed in this country. The same thing is going on here as in other countries; we have the same tumble stone foundations, the same methods of masonry or concrete blocks, with masonry superstructure. The same difficulties with regard to want of continuity of structure, the same moving silt, shingle, and *débris*, the same obstacles attending attempts to utilise the mouths of rivers and estuaries, the same frightful expense, labour, and delays accompanying all acknowledged systems of harbour construction, which have been known at all times since the beginning, have all occurred in this country, and, if not with shame, let us at least admit, with regret, that the severe strictures, openly insinuated, or inferred, in the reports of the

Royal Commissions appointed by the Government of this country from time to time, within the last fifty years, are not altogether undeserved.

DISCUSSION.

Mr. L. F. VERNON-HARCOURT said every one must have been much pleased with the views of natural harbours and sections of breakwaters which were shown, but it struck him, in listening to the paper, that the author had hardly had sufficient experience to enable him to deal thoroughly with the question, and without experience, it was hardly wise to find fault with what had already been done, especially when the limits of accuracy were not strictly observed. It was not correct to say that no advance had been made on the *pierre perdu* system, because, besides the Dover pier, which, being the first upright wall breakwater, was costly, though not so costly as had been stated, the cost of the outer portion, per lineal foot, being about £250 in 45 feet of water, not £360, there were other breakwaters which had not been referred to where a different system was adopted. For instance, there was Newhaven breakwater, where there was the continuity which was proposed; bags were put in, of about 100 tons weight, at the bottom, and afterwards a monolith structure was built above. This breakwater cost £54 10s. per lineal foot. The author had exhibited a view showing a proposition suggested for improving the Dover harbour, and in the original scheme there was a proposal to enclose the bay by a very large breakwater, which the author said would have had to be some distance out, because, on the *pierre perdu* system, it would interfere with the area of the bay—forgetting, for the moment, that the Dover pier was not constructed on that system. He also said there had been a failure in the breakwater itself. He (Mr. Vernon Harcourt) had not heard of any failure, however, in the lower part; some accidents had occurred to the parapet and other parts above, but he had never heard of any below. Again, the statement that the Tyne breakwater had made very slow progress, and was not yet finished, was hardly fair to the River Tyne Commissioners. They were induced by the Government to carry out a harbour of refuge, which really was not required of such a size, for the purpose of improving the river; and they went in for a larger scheme than they would otherwise have done, probably hoping for Government aid, which they did not receive, and, consequently, deficiency of funds had delayed the work. With regard to rapidity of construction, he need only refer to the Alexandria breakwater, which was not made on the old mole, but in another position, and which was carried out for nearly two miles in length in two years. With regard to Colombo, which was said to have cost £170 per lineal foot, he happened to have gone into the figures that day—given in a paper read in 1886 at the Institution of Civil Engineers—and found that the cost

was really about £142, though he acknowledged that in a book written six or seven years ago, without the knowledge he now possessed, he had himself put the cost at £170 per foot. He was astonished to to hear it said that the wooden piles in the south breakwater at Aberdeen were put in to keep the structure together. He had never heard of such a suggestion before, and happened to know that they were put in to support the staging carrying out the work, certainly not for the purpose of holding the blocks together. He approved of the vertical wall when it could be employed, but did not agree with the author that there would be only a statical pressure of water against it during storms. In his opinion, there would equally be the impact of the waves, though there was the advantage of not having a breaking wave. He was for two years in charge of the breakwater at Alderney, which extended into a depth of 133 feet at low water, and it would have been impossible to have had a vertical wall there. But the mound breakwater with concrete blocks, or a superstructure at the top, answered very well, as at Alexandria, Port Said, Algiers, Manora, Colombo, and other places. Where a *pierre perdu* mound, plenty of materials must be available, and where the bottom was sand, a vertical wall alone was not practicable, as it requires a solid foundation of some kind. The great cost of the Dover Breakwater was owing to the immense expense incurred by diving operations, in dressing the chalk to receive the blocks. At Newhaven, that cost was considerably reduced by simply having bags which fitted themselves to the chalk, as had been done at Aberdeen before, where the South and North Piers only cost £65 and £46 per lineal foot. The advance which had been made in breakwater construction, mainly by the use of Portland cement, ought to be acknowledged. Then it was said that all these difficulties of large cost of construction, slow progress, and cost of maintenance, were to be cured by the adoption of Mr. Lewthwaite's system, which, it was said, would only be one-tenth the cost, and could be carried out with great rapidity on any foundation. He would reserve his opinion until it had been tried; but, as far as he could see, if it were put on a foundation of sand, the sea would act just in the same way as it did in other places, and would scour alongside the breakwater as it did at Ymuiden, at the North Sea entrance of the Amsterdam ship canal, where they were obliged to put a kind of floor of basalt to prevent the scour at the foot of the breakwater. It was proposed to put a kind of skin of concrete blocks, tied together by iron rods, and then fill in the space with sand, chalk, or stones. His opinion was that, if it was filled in with sand, the sand would soon be washed out; the breakwater would consist simply of the partition walls, and at the first heavy storm it would be overturned. If chalk were used, it would have to be rammed very tightly, or it would not be of much use either, and he doubted therefore whether the scheme could be successful. It was possible

that the system might be useful for many sheltered sites, or as an outer casing, under shelter of which concrete in mass might be deposited. He should be very glad to see it tried, and should be glad to hear further particulars of the locality where it was to be used. One very important point was the fetch of the sea; how far the direction of greatest exposure was from the nearest land, and the depth of water in front. It would not do to compare a breakwater high up the Bristol Channel with one exposed to the Atlantic. He had evidence of this when in charge of Alderney Breakwater, which was very subject to breaches; whilst St. Catherine's, Jersey, also under his charge, which was made in a less continuous manner, and where there was a much greater rise of tide, suffered very little. In the one case, there was an exposure to the Atlantic, with a fetch of one or two thousand miles; and in the other, it was only 15 or 20 miles to the French coast; and there was also a great difference in depth at the ends of the breakwater. He learned there that the most important point in connection with a breakwater was the exposure and the depth, and that experience was indispensable for the successful execution of sea works. He was sorry to have to disagree so much with Mr. Cheesewright, but he had been engaged a good deal in this kind of work, and thought experience was much more valuable than theory.

MR. CHEESEWRIGHT said he had taken the cost of the Dover Pier from the Government Blue-books, and if they were in error, he could not be responsible. Mr. Stevenson also, in a work on breakwaters, gave the same figure. With regard to Tynemouth, if the cost had been very small, though it had taken a good many years to make, the two things could have been reconciled, but, as a matter of fact, not only had it taken a long time, but had cost a tremendous lot of money. At Brean Down, where the new system was to be tried, the depth of water at the end was 35 feet, the rise of water 40 feet, and it would be 10 feet above high water; one end would be connected with the shore, and the length would be 1,760 feet. It was exposed to the entire force of the sea from the west, and was designed, in fact, to protect anchorage. This spot had been favourably reported on by Sir John Coode as the most suitable in the Bristol Channel, provided a breakwater could be erected to stop the effect of the westerly and south-westerly winds.

The CHAIRMAN, in moving a vote of thanks to Mr. Cheesewright, said it was a matter of great moment to the country that breakwaters should be efficiently constructed, and he was glad to hear that Mr. Vernon-Harcourt approved of a vertical wall system in preference to a slope, because, though not an engineer, he thought it was evident that the vertical wall would stand better. With a sloping wall the sea came in with a great send, and the water was driven up the slope; whereas against the vertical wall there must always be a certain amount of dead water, which would act to some extent as a buffer

against the incoming wave. That was probably one reason why the Dover Breakwater had not suffered in the recent gale, although the sea made a clean breach over it, and the shingle and pebbles were carried right over. That was the nearest approach to the vertical shape at present, except at Colombo. Of course, one instance was not conclusive, but its success was a strong argument in favour of the system.

The vote of thanks having been carried unanimously, the meeting adjourned.

Miscellaneous.

CHICAGO EXHIBITION, 1893.

The Science and Art Department have forwarded to the Society a copy of the general regulations for foreign exhibitors at the Chicago Exhibition, 1893. The Exhibition is to be opened on the 1st of May, 1893, and closed on the 30th of October. All Governments have been invited to appoint Commissions for organising the foreign sections. The duties of these Commissions will be the same as in previous International Exhibitions, applications for space having to be addressed to the Commission of the country where the article is produced. The general reception of articles at the Exhibition is to commence on the 1st of November, 1892, and no articles are to be admitted after the 10th of April, 1893; but special installations will be permitted to be commenced as soon as the condition of the buildings allow. Products intended for competition must be so described; if not, they will be excluded from examination by the juries. The official catalogue is to be in English, French, German, and Spanish. The following are the twelve divisions of the classification:—

- A.—Agriculture, forest products, forestry, machinery and appliances.
- B.—Viticulture, horticulture, floriculture.
- C.—Live stock—Domestic and wild animals.
- D.—Fish, fisheries, fish products, and apparatus for fishing.
- E.—Mines, mining, and metallurgy.
- F.—Machinery.
- G.—Transportation—Railways, vessels, vehicles.
- H.—Manufactures.
- J.—Electricity.
- K.—Fine Arts—Pictorial, plastic, and decorative.
- L.—Liberal Arts—Education, engineering, public works, architecture, music, and the drama.
- M.—Ethnology, archæology, progress of labour and invention, isolated and collective exhibits.

A limited amount of steam and water power will be supplied gratuitously. Power in excess of that allowed gratuitously will be furnished at a fixed price.

Special regulations are to be hereafter issued regarding the Fine Art Section, the organisation of the International juries, the sales within the building, and other points.

General Notes.

PRUSSIAN SAVINGS BANKS.—The *Statistische Korrespondenz* of Berlin states that at the end of the financial year, 1889-90, the number of accounts open in the Prussian savings banks was 5,312,192. As compared with the preceding year, this shows an increase of 283,018 accounts. During this year the amount standing to the credit of the savings banks rose from 144 millions sterling to 155 millions; that is an increase of 11 millions. This increase, which comprises nearly 4 millions as interest added to the various accounts, was only exceeded in 1888-89, when the amount standing to the credit of depositors increased by 12 millions. The total amount of 155 millions is distributed as follows:—Westphalian depositors, 26 millions (17·2 per cent.); Hanoverian, 21 millions (13·6 per cent.); Rhenish Prussians, 21 millions (13·5 per cent.); Saxons, 18 millions (11·5 per cent.); Schleswig Holstein, 18 millions (11·4 per cent.); and other districts are represented by the amount of 51 millions. In 1889-90, the average amount due for each depositor was £29, as compared with £28 in the previous year. The deposits rose to 41 millions, against 38 millions in 1888-89, and the repayments amounted to 34 millions, as compared with 30 millions. In 1889-90, 894,376 new accounts were opened, and 621,380 were closed. As regards the number of banks, there were 1,378 in 1889-90, as compared with 1,363 in 1888-89. It is stated that a fifth of the total population, including children, have accounts open in the various Prussian savings banks.

FOOD CONSUMPTION IN VIENNA.—The population of the city of Vienna is about 800,000, and with the suburbs and neighbourhood, over 1,000,000. The consumption of animal food in 1888 consisted of 77,512 cattle, 147,978 calves, 31,469 sheep, 37,105 head of lambs, kids, and sucking pigs, and 178,466 pigs; of meat, 189,171 metrical quintals; of game, 2,377 deer, 871 wild boars; chamois and other game, 10,221 head; hares, 201,221; pheasants, 27,048; partridges, 112,778; of poultry, 898,968 pairs of fowls and pigeons; 485,775 pairs of geese, ducks, turkeys, and capons; of fish and crayfish, 12,851 metrical quintals; of butter, oil, and fat, 35,848 metrical quintals; of eggs, 83,750,000; honey, 694 metrical quintals; rice, 13,210 metrical quintals; flour, 525,795 metrical quintals; bread, 176,437 metrical quintals; wheat, 36,288 metrical quintals; legumes, 75,102 metrical quintals; asparagus, 333 metrical quintals; cauliflowers, 4,198 metrical quintals; fruits, fresh, dried, or preserved, 256,523 metrical quintals; liqueurs, 62,500 hectolitres; wine, 361,300 hectolitres; beer, 1,039,000 hectolitres. There were also killed by the butchers for food 6,277 horses. The price of meat per kilogramme (2½ lbs.) was, beef, 18 to 66 kreutzer; pork, 32 to

82 kreutzer; veal, 20 to 70 kreutzer; mutton, 20 to 60 kreutzer. The average number of fat cattle arriving weekly was 4,765 head.

MEETINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 24. — CLEMENT HEATON, "Uses of Cloisonné, Old and New." SIR HENRY DOULTON will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Prof. R. MELDOLA, F.R.S., "Photographic Chemistry." Three lectures.

LECTURE III.—MARCH 23.—The action of light on the silver haloids—Accelerators and retarders of photo-chemical decomposition—The invisible products of the action of light on the haloids—Sensitive films—The function of the vehicle in modern emulsions—The invisible effect of light on the haloids—The photographic image—Development and subsequent processes.

MEETINGS FOR THE ENSUING WEEK.

- MONDAY, MARCH 23... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. R. Meldola, "Photographic Chemistry." (Lec. III.) North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m. Mr. William Mountain, "Electrical Engineering, with special reference to Electric Lighting."
- Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. G. P. Baker, "Travel and Ascents in the Basardjusi District, Daghestan." 2. Mr. Douglas W. Freshfield, "Notes on Exploration and Photography in the Caucasus in 1890."
- British Architects, 9, Conduit-street, W., 8 p.m. Actuaries, Staple Inn-hall, Holborn, 7 p.m. Medical, 11, Chandos-street, W., 8½ p.m. London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Norman Lockyer, "The Orientation of some Ancient Temples."
- TUESDAY, MARCH 24... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Clement Heaton, "Uses of *Cloisonné* for Decoration in Ancient and Modern Times."
- Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. A. Wynter Blyth, "Sanitary Laws and Regulations Governing the Metropolis."
- Medical & Chirurgical, 20, Hanover-sq., W., 8½ p.m. Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. W. T. H. Carrington, "The Reception and Storage of Petroleum Oil in Bulk."
- WEDNESDAY, MARCH 25... Geological, Burlington-house, W., 8 p.m. 1. Mr. S. S. Buckman, "Notes on Nautili and Ammonites." 2. Mr. G. W. Lamplugh, "The Drifts on Flamborough Head." 3. Mr. A. Strahan, "A Phosphatised Chalk, with *Belemnitella quadrata* at Taplow."
- Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m. Chemical, Burlington-house, W., 8 p.m. Anniversary Meeting. Election of Officers and Council.

Journal of the Society of Arts.

No. 2,001. VOL. XXXIX.

FRIDAY, MARCH 27, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Professor R. MELDOLA, F.R.S., delivered the third and last lecture of his course on "Photographic Chemistry" on Monday evening, 23rd inst.

In his concluding lecture Professor Meldola dealt with the action of light on the silver haloids, the invisible products of the action of light, and their development into a visible image. He also dwelt on the action of sensitisers, and on the effect of the vehicle in which the sensitive salt was contained.

A vote of thanks to the lecturer for his course was passed on the motion of the CHAIRMAN.

The lectures will be printed in the *Journal* during the autumn recess.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 17, 1891: B. FRANCIS COBB, Vice-President of the Society, in the chair.

The paper read was—

RECENT DEVELOPMENT OF TASMANIAN INDUSTRIES AND PROSPERITY.

By SIR EDWARD N. C. BRADDON, K.C.M.G.

Colonial stocks are as much dominated by fickle fashion as millinery and upholstery, and subject to equally captious changes. Two

years ago, a financial friend of mine spoke of the public debt of Tasmania as a mere bagatelle; more recently, although Tasmania's position in this particular has not materially changed, that same authority has adopted a very different tone. "The Australasian Colonies are borrowing too much," he says. "They are coming to us too often for loans." And no doubt what he feels in this respect is felt by many others, and is the main reason why latterly the quotations of our $3\frac{1}{2}$ per cent. inscribed stock have fallen considerably. That stock is out of fashion. The wheel will doubtless turn, ere long, and that stock will come into vogue again.

What is that Australasian debt as to which my financial friend now entertains this doleful view? 180 millions. That amount having been borrowed mainly for reproductive public works—for the most part railways that now yield a considerable profit, and which, it may be hoped will, in the near future, give a net return equal to the interest due upon the capital cost of their construction and equipment. What is 200 millions in such a case as this?—a bagatelle, as my financial friend justly observed before the pessimistic mood had dulled his perception. Why the capital of two English railway companies—the Great Northern and London and North-Western—aggregate 152 millions, or more than three-fourths of the debt of Australasia.

While my financial friend and many others have a very keen appreciation of the growth of Australasian indebtedness, I think there are very few who realise to the fullest extent the wonderful growth of that group of colonies in other and more encouraging aspects. They do not give adequate consideration to the abundant evidence before them that the security for our debt is ample for a very much greater liability—that the Crown estate is sufficient alone for this; while the guarantee afforded by private wealth may be gauged by the simple fact that the savings represented by bank and savings bank deposits almost equal the amount of the public debt.

The comparison between Canadian and Australasian progress presents, to my mind, a very striking illustration of the marvellous character of the prosperity achieved by the Australasian group. It shows that, grand a dominion as is that of Canada, Australasia has in little more than a century accomplished greater things in many ways than Canada in 283 years of colonisation. And a comparison made with all the civilised nations of the

earth shows that as to the imports, exports, and average annual earnings per head of population Australasia occupies the first position.

The following figures are taken from the

latest edition of Mulhall's statistics, which are brought down to 1880-81 only. But, for the purposes of the comparison I am making, these statistics are probably more favourable to Canada than later ones would be :—

	Australasia.	Canada.
Capital employed in banking	£85,000,000	£35,000,000
Annual earnings	£133,000,000	£118,000,000
„ „ per head of population	£44	£27
Wealth „ „ „	£187	£148
Imports „ „ „	348s.	86s.
Exports „ „ „	350s.	86s.
Annual value of agricultural products	£76,000,000	£58,000,000
* Cattle	16,000,000	no mention.
„ (per inhabitant)	5.73	0.91

And this wonderful growth in Australasia has been, generally speaking, steadily progressive. Now and again prosperity has advanced by leaps and bounds (as is now the case in Tasmania). Anon there have been seasons of depression, when the pessimist bewailed the altered times, and the Parliamentary opposition pronounced the country ruined beyond redemption. But even while there have been lamentations of this sort, and presages of woe, population, and general wealth have increased, and if the leaps and bounds forward have sobered down into a somewhat halting gait, there has been no serious retrograde movement.

I think it possible that the Australasian colonies are hypersensitive to depression, and find a strange delight in a crisis, financial or political. Let a temporary decline of revenue, or a partial failure of some crop occur, and lo ! there will be those quite ready to manufacture a crisis out of it, and cry woe throughout the land. They take no shame because their predictions are falsified by events; they are quite satisfied to share in that prosperity which comes in lieu of the ruin they had foreseen; and hold themselves in readiness to again become prophets of evil at the first opportunity.

Tasmania (which I am happy to say has the smallest debt per head of population of any self-governing colony of Australasia, except Western Australia, which is now on the top of fortune's flood) is no exception in respect to these fluctuations. During the last decade she has had her reverses and her successes; there have been times when her revenue was buoyant, and the treasurer boastfully speaking of his surplus, asked "What shall we do with it?" There have been times

when it was difficult to make both ends meet, and when the treasurer had to ask as to a deficit what should be done with that. But there has always been a general advance in material wealth during that period; a continual improvement of the condition of the people by railways, roads, telegraphs, &c.; a constant development of settlement and opening up of new mineral areas, and an ever increasing population and expanding industries.

Taking the ten years 1880 to 1889, we find that in the first of these years the Parliament of Tasmania assembled with the object of rescuing the colony from a financial crisis, represented by a deficit of £130,000. A coalition Government was formed to carry out this formidable task, and, in the absence of opposition, new taxes were proposed and carried, as it were, by acclamation. In 1882, the deficit had been expunged, and the treasurer found himself in a position to remit taxation to the extent of some £40,000 a year. In 1885, a new deficit raised its ill-omened head, and grew and flourished until 1887, when new taxation of some £35,000 checked it; but it was only in the year just gone by that a surplus was obtained wherewith to pay off a substantial portion of the deficiency.

Yet during all the years of that decade we find the population increasing by 2,293, 3,601, 3,553, 3,741, 4,321, 3,350, 3,420, 5,267, 3,671, and 5,331. The total increase of the period being 36,741—equal to 32 per cent., at which rate the population would be doubled in 25 years; and it is a noticeable fact that in two of these lean years, *i.e.*, in 1887 and 1889, the increase in population (5,267 and 5,331 respectively) was greater than in any other; and that in these two years only did the increase of

* Cattle includes horses, pigs, and sheep—pigs and sheep at the rate of ten per each head of cattle.

immigration over emigration exceed that of births over deaths.

During that period, deposits in ordinary banks increased from £2,122,091 in 1880 to £3,958,848 in 1889. This increase was not continuous from year to year, for in 1886—the second year of leanness—these deposits touched their maximum of £4,127,946. But deposits in savings banks—the savings of labour—did throughout the decade almost uninterruptedly grow from £310,080 in 1880, to £497,491 in 1889.

The annual value of property assessed for rates rose from £705,032 to £923,657; the capital value of real estate rose to £21,000,000, or to £139 per head of population; and an estimate of the value of all property gave to every man, woman, and child, Tasmanian, £240.

The revenue of that period increased year by year—with one exception, in 1886—from £442,157, in 1880, to £678,909 in 1889; but, unfortunately, although, to a great extent, necessarily, the expenditure more than kept pace with it, rising from £415,195 to £681,674. In 1890, however, the revenue rose to £753,700, as against an expenditure of £722,000, giving a surplus of £31,000. The increase of income from 1880 to 1890 is equal to 70 per cent., and that growth is due, not to a constantly increasing taxation, but to the development of normal sources of revenue, consequent upon increased population and national wealth. The growth of expenditure has been mainly the consequence of an increase in the cost of the public service, inevitable with a growing community, and the additional annual charge for interest upon £3,623,750 borrowed during the decade for the construction of railways and other reproductive works. Those additional borrowed millions represent an annual charge of about £145,000 borne, and wisely borne, by this generation for the benefit of generations yet to come.

The progress in settlement during that decade is shown (1) by the fact that while the average sale of agricultural Crown lands during the five years, 1880 to 1884, was 40,072 acres, the average for the last five years, 1885 to 1889, was 48,950 acres; and (2) by the increase of the land under cultivation from 373,299 acres in 1880, to 488,354 acres in 1889.

And during that period, our shipping, inwards and outwards, increased from 1,309 vessels, aggregating 413,303 tons, to 1,565 vessels, aggregating 777,073 tons. Our post-offices from 201, delivering 4,878,062 letters,

post-cards, and newspapers, to 278, delivering 10,238,896 letters, post-cards, and newspapers; our telegraph stations from 64, with 963 miles of wire open, to 160 with 2,097 miles of wire; our railways open, from 167½ miles to 496½ miles; and I regret that I cannot show with sufficient brevity how the progress made in road construction has, during those ten years, brought facilities of communication fast on the heels of settlement, and opened up markets to thousands of hard-working farmers to whom, in the old time, the kangaroo tracks, called roads, were but sloughs of despond.

While Tasmania has been thus progressing in the ordinary grooves, her mining, which from time to time has done so much for her, has been persistently pushed on by prospectors and investors, with the result that now, in 1891, that colony may well hope to occupy a leading place among the mineral-producing colonies of the British Empire. In 1879 the great Mount Bischoff mine (which has now given to its shareholders over one million sterling in dividends) raised the drooping spirits of Tasmanians in a time of depression; it was said to have saved the colony. Parliament voted a pension of £200 a year to its discoverer, and a statue in his honour is now contemplated, even though he is alive to look upon it. In 1890 the West Coast silver fields of Mounts Zeehan and Dundas gave a splendid impetus to the revenue of the Treasurer, and in 1891 the mines of that field bid fair to make Tasmanians rich beyond the dreams of avarice.

But during the years 1880 and 1889, although much dead work was done whereof the fruits will now be gathered, the output of minerals (gold and tin) made no decided advance. In 1880 the total value of gold and tin exported was £543,391; in 1880 the maximum total of £587,028 was reached. In 1887 and 1888 the output exceeded that of 1880, being £548,441 and £553,888 respectively; and in 1889 it fell to £468,893. As a set-off against this stagnancy in gold and tin outputs, coal has made a considerable advance, and the outputs of 1888 and 1889 reached 41,577 and 40,300 tons respectively, as against an average for the preceding eight years of 11,620 tons.

And if this progress be slow and halting, the difficulties that attend prospecting operations in Tasmania sufficiently explain this. The mineral-bearing area is relatively vast, and, in a greater or less degree, extends throughout the island; but much of the country is broken, hilly, heavily timbered, and destitute of roads.

A great amount of it is a *terra incognita* untraversed by any human being, uncharted, unsurveyed. The prospector who penetrates these wilds goes forward, as it were, with his life in his hand, and, what he feels still more, a heavy swag upon his back, that is his board and lodging all in one. It was after many years of severe toil that Mr. James Smith discovered the valuable tin mine of Mount Bischoff, which has supported for thirteen years the town of Waratah, with its 2,000 people; kept a railway of forty-eight miles going; distributed 2,000,000 of money in labour and dividends; and made Emu Bay an important port of the north-west coast. It was after years of unavailing work that the Tasmania gold mine was made remunerative, so remunerative, that in fourteen years it has yielded over £500,000 in dividends, and distributed some £750,000 in wages and cost of plant; while it has kept in existence and flourishing the mining town of Beaconsfield, with its 1,500 people. And now, Mount Bischoff and the Tasmania, with many smaller mines still remaining to us, our resources are swollen by the newly-established gold mine—the Golden Gate—of Mathinna, which now ranks as the equal of the Tasmania (and for which the proprietors recently refused £250,000 cash); and by the silver and silver-lead mines of Mounts Zeehan and Dundas, that promise to outvie the famous Broken Hill.

Three years ago, while I was yet in Tasmania, men were sanguine as to these west coast silver mines; experts from the continent of Australia had visited and reported favourably upon the claims then known; capital flowed in from Victoria, New South Wales, and South Australia; 36,000 acres were leased or applied for as silver claims between Mounts Zeehan and Dundas; and a small township was struggling into existence at Zeehan. The promise was so gratifying, and so largely confirmed by the Government geological surveyor, that the Government were induced to undertake the construction of a line of railway from Mount Zeehan to the port of Strahan (Macquarie Harbour), and only when this line is opened, three or four months hence, will the mines be brought into full bearing. Not till then will the heavy plant required for pumping the mines and treating the ore be placed upon the various mining properties, and then only will the silver and lead be brought into the market in quantity.

But enough has been done in the way of dead work to show that the lodes improve in

depth, and that the area of silver-bearing country is wider than was anticipated; 72,500 acres had been leased or applied for at Mount Zeehan and Mount Dundas three months ago; and whereas bulk assays that yielded 80 oz. per ton were thought eminently satisfactory in 1888, the ore at a lower depth has yielded various results from 130 oz. to 260 oz.

For at a cost of £7 a ton, or more, for carriage to the port of Trial Bay, quantities of ore of 30, 40, and 50 tons have been got out and smelted in Melbourne or Adelaide. Fifty tons from the Silver Queen treated recently yielded an average of 232 oz. per ton; 40 tons from the same property gave 260 oz. Other local companies have had bulk tests with very hopeful results, and the English Mount Zeehan company have brought to this country 95 tons, which have given a result of 101 oz. per ton in silver, and 60 per cent. in lead, and have here or on the way 332 tons more, which are expected to yield equally good returns. This English company expect, when the railway is working, to produce 50 tons a day; or say for 300 working days in the year, 15,000 tons, equal to a net value of £379,500; and this expectation is encouraged by the latest news from the company's mine, viz., that the manager has driven through a splendid lode twelve feet in width. So far we had been satisfied with lodes of four or five feet in width; but we can bear with equanimity greater wealth than we had looked for; we could endure philosophically the possession of many mines such as the recently-discovered Maestree's mine at Mount Dundas, which a report in the *Melbourne Standard* values at £5,000,000.

The development of those west coast silver mines, partial though it be at present, has already made the towns of Zeehan and Strahan places of some importance, and caused some extent of agricultural settlement. Ten years ago, that part of the district of Cumberland had no place on the electoral roll; the mining vote had no existence. To-day, that vote outnumbered the vote of the agricultural and pastoral portions of the constituency, which have been settled for generations; and, while the mining population, with their followers, may now be estimated at something like 1,000, it may reasonably be expected to increase to 3,000 or 4,000, when the opening of the railway shall have brought the silver mines of Zeehan and Dundas into full swing; and led, as it doubtless will, to the further development of the tin mines of Reminé, the gold mines of Mount Lyall, King River, and Princess River, the

marble quarries of Gordon River, and all the other wealth of the west country.

May I ask your attention for a few minutes, while I show what, at a reasonable computation, the silver mines of Zeehan and Dundas will do for the promotion of the national wealth. They may be expected to add certainly £1,000,000 sterling, possibly £2,000,000, to the value of our annual exports. They will pay as rents, for a time, at all events, £18,000 to £20,000 per annum. They will keep up a population of, say 3,000 people on the spot, and those 3,000 will contribute to the customs, at £2 16s. a head, £8,400 per annum; and they will maintain a railway with such success as to relieve the State from any charge for interest upon the borrowed money invested in it. Those are the principal of the direct advantages: a clear gain to the revenue of £26,000 to £28,000, and a profitable railway. The indirect gains would also be considerable; but these it is only desirable to generalise, as the effects upon the whole community of the prosperity of a new and thriving industry, and the encouragement given to capitalists, prospectors, and others to push on with the development of other mines—silver, gold, and tin—in the rich mineral country of the west coast.

It should be explained, that mining in Tasmania is, after all, an industry of quite recent creation. While the colony dates from 1804, the discovery of gold and tin bear date in the latter day years 1867 and 1873; and it was not until 1879 that exports of gold and tin together reached the level of the wool exports. It is possible that the introduction of the fascinating pursuit of mining may have been one of the causes of the decline in whaling, wherein Tasmania had always done the lion's share in southern waters. In 1848, 38 whalers sailed from Hobart. These vessels aggregated 7,260 tons, were valued at £148,000, and manned by 1,100 men. In fact, in 1840, about 2 per cent. of the total population were engaged in this occupation. In 1869, Franklin Westcott, a whaler, arrived in Hobart, and counted 23 whaling vessels in that port, at that time Sydney had seven or eight. New Zealand had, between 1880 and 1887, three. Now, Hobart's whaling fleet has dwindled down to two vessels, Sydney has one, and New Zealand none.

A return, showing exports of sperm and black oil for each fifth year from 1857 to 1882, and for the year 1886, shows that these reached a maximum in 1862 with a value £59,210; in

1872 they were £47,575; in 1877, £33,507; in 1882, £13,170; and in 1886, £9,463 only.

But little attention was paid to black whale fishing, although the black oil is more valuable than the sperm. In only four of the seven years quoted was black oil mentioned in the exports, and the total exports for those four years aggregated £2,661 only.

I trust that we may see a revival of this industry side by side with an ever-increasing activity in mining. And there seems to be no reason why this should not be. Apart from the fact that the old whaling ground of Tasmania has now had comparative rest for some years, there is the point in our favour that steam whalers fishing along the margin of, and amongst, the Antarctic flocs, would reach a field never yet touched by the sailing vessels hitherto employed, and the estimate of an expert shows that the business ought to result in a substantial profit. The calculation of this authority is as follows:—

Eight months' ordinary whaling voyage costs, if clean	£3,500
Add oil money to crew and realising expense on 100 tons	1,500
Total	£5,000
100 tons oil at £20	£2,000
5½ „ whalebone at £1,500..	8,250
	<hr/> 10,250
Profit	£5,250

And if the yield exceeded 100 tons there would be a more than proportionate increase of profit; for example, if the catch were 150 tons, the additional value of the 50 tons would be £5,125, while the additional cost would be only £750, giving additional profit of £4,375; making in all £9,625. The cost of a good substantial second-hand steam whaler is put down at from £4,000 to £9,000, according to age, capacity, and power of the vessel, and the equipment, including outfit, provisions, and insurance, for an eight months' voyage, at £1,500.

Here would appear to offer an opportunity of employing, with the very best results, the hardy fishermen and crofters of Scotland; and the idea is rendered all the more feasible by the fact that during the four months that the men would be unemployed in whaling, and, as to some portion of them, throughout the twelve months, ample occupation would be available for them in deep-sea fishing round our coasts, and the curing of fish. Some inquiry has been made recently as to the

practicability of settling these fisherfolk in localities where they could cultivate small farm and garden allotments, and wring wealth from the land as well as from the sea. Such suitable places have been reported upon, and it only remains to bring the crofters or others to them.

So far the fishing industry of Tasmania has been terribly neglected. Fish swarm in the waters that break upon her shores; some of them, such as the trumpeter, trevally, rock-cod, and king fish, equal to the best found in the Northern hemisphere—some of them, also, unknown in the warmer regions of Australia; and Tasmania might open up a highly remunerative fish trade with Melbourne, Sydney, Adelaide, and Brisbane, if her people caught the fish and had the necessary equipment, not only for catching but for carrying them to markets on the continent. As it is, not even the local market is either regularly or sufficiently supplied, and in the capital of Tasmania the local market is generally represented by Mrs. Cairns' oyster shop, where, as often as not, the housewife looks vainly for the fish she requires, or any fish whatever. As a resident of Hobart I was told that if I went down to the wharves when the owners of the fishing smacks sold their catches, at 6.30 or 7 a.m., I might purchase plenty of fish at a moderate price. But, even if the hour of 7 a.m. had not been prohibitory, it struck me that the time and energy required for ascertaining when the smacks were to come in might be devoted to some higher and more profitable study, so that this source of supply was closed to me, and beyond the precarious market of Mrs. Cairns' shop I could look for fish only from an itinerant barrowman, whose visits were rendered episodic by occasional interruptions in his liberty directed by the Bench.

I have myself seen shoals of a small species of mackerel come into the estuary of the Forth, and absolutely offer themselves for capture in vain. There has been nobody prepared to take them, and they have gone away back into the deeps. So is it elsewhere on Tasmania's coasts and with other fish—and this excellent article of food (whether fresh or smoked), is not one brought within the reach of the consuming public of the colony in anything like sufficient quantity. At the same time, the Government and patriotic individuals have expended considerable sums in increasing the fish supply by acclimatisation, and with the result, that salmon, salmon trout, and trout are now established in Tasmanian streams, and may

be caught by the angler who has the necessary skill. For three or four years a Fisheries Department existed, under the superintendence of Mr. Savill Kent; and now the fresh-water fishing and oyster culture are managed by a Board. But deep-sea fishing yet awaits that attention to which the occasion demands.

Would that the labours of the State-Aided Colonisation Committee, now considering their report to the House of Commons, might result in the settlement upon Tasmania's coast of a hardy race of whalers and fishermen, who, while life is here for them one long drawn agony of want, may there find plenty, and wholesome liberty from the mill-round of too constant toil. There is no British possession that offers a better field or more suitable climate for them than Tasmania. There is no colony so essentially British, and where the Englishman or Scot, fresh from his native soil, may find himself so thoroughly at home—so completely in unison with the speech, manners, and customs, the every day business and relaxations of his new fellow countrymen.

It is the water around her shores, and not her land, that Tasmania neglects. Agriculture expands and prospers, even though methods be somewhat rude, and labour costly. The farms that have paid best are those that have been cultivated solely, or almost solely, by the owner and his sons. Possibly the owner bought the freehold from the Crown at £1 6s. 8d. per acre, payable in fourteen annual instalments, and began operations by clearing the heavy timber that had shut the sun out from the soil for centuries. That man will have won his success by a peaceful triumph not less glorious than many won upon the stricken field. The bush has been his Ramilies, Blenheim, or Malplaquet, and he the irresistible Marlborough, full of courage and self-reliance. Out of the fallen eucalypt (his friend and foe in one) he has split the material for his homestead, his barn and byre, and the fences that enclose his fields. He has split therefrom palings and shingle for the local market, or for export to the neighbouring colonies; and the proceeds have helped to keep him in the earlier days ere yet his land was cropped. And now he is a well-to-do yeoman farmer, with plenty at his board, comfort in his home, and leisure for rational amusement. Scores of such men, within my knowledge, have won their way to this position from that of farm labourers. There is

room for many more such men: there is land awaiting them, and there are greater facilities in the way of roads, railways, and harbours for the new comers than the early pioneers dreamed of.

The success of the many farm labourers who win their way to mastership, to a great extent, explains why labour is often scarce and always well paid. Recruits flow in, but independence wins many from their ranks, and masters increase with the men.

Agricultural farming, mainly by small freeholders, has extended, and is extending steadily; and, in the course of time, may be sufficient, without the adventitious aid of mining, to maintain Tasmania's position as a prosperous colony. Fruit-growing is also extending with the most gratifying results. Nowhere in the world are the fruits of the temperate zone (apples, pears, cherries, apricots, plums, &c.) grown of greater excellence or in equal profusion. Orchards of 60 acres in extent are to be seen in the Huon country. Hobart is embowered in orchards which extend with few breaks through the suburbs of New Town and Sandy Bay. Orchards, alternating with hop grounds, make New Norfolk, on the banks of Derwent, another and brighter weald of Kent, and everywhere that the apple grows it ripens in an air like liquid sunshine. Tasmania had until quite recently only a narrow outlet for her wealth of fruit. She supplied the markets of Australasia generally, but there her export trade began and ended. Now she has established a trade in apples with the mother country. Over 30,000 bushels were sent to England in 1889; nearly 50,000 bushels were sent last year. This year I am told that freight has been engaged for 140,000 bushels; and as Tasmanian apples have now acquired a standing not only in London but in the large cities of the North, the trade may grow from year to year until England shall rank as the market for this product; more than this, trial shipments made last year bid fair to make San Francisco a large and profitable market for our fruit. Within the decade ending 1890 the growth of the vine has been introduced, and has converted Maria Island, at one point, from a sterile waste into a garden. Wine of a fair vintage was produced in 1887, and year by year the out-turn is increasing.

And I am not without hope that, similarly, Tasmania's timber trade may be largely extended by business with England. Hitherto considerable quantities of hard wood, black-

wood, and Huon pine, have been exported to Australia, and the sawmills of the Huon, and the mills and splitters of the north-west coast have been busy furnishing the supply required by the colonies on the further side of Bass's Strait. But much of our timber consists of highly ornamental woods (the blackwood, Huon and King William pines, the myrtle and the musk), which, if fashion here would but so decree, might be largely and beneficially employed in this country for furniture, by way of a change from the stereotyped mahogany, oak, and walnut.

While her agriculture and orcharding are thus promising, I do not think that any expansion of Tasmania's pastoral interests may be looked for. I cannot hope that such expansion will occur. Rather I should desire to see the large sheep runs cut up, as Quamby was the other day, and Lourenny may be to-morrow, into small agricultural holdings. I would much rather see men upon the land than sheep; and this is, I trust, what we are destined to behold. The Tasmanian wool exports reached their maximum of £542,244 in 1880. I do not think that maximum will be largely exceeded in years to come.

But one pastoral pursuit in Tasmania—that of stud sheep rearing—may well enlist the sympathy even of the advocate of “three acres and a cow.” Tasmanian stud sheep rank first in the Australasian sheep world. They have realised prices up to certainly 1,125 guineas per head; and the value of the annual exports of these valuable creatures has reached £66,743; and for the decade under consideration, averaged £47,642 per annum.

Manufactures have, during the years 1880 to 1889, made some advance. Iron ships were built for the first time; woollen mills made progress; potteries were established with success; and other industries kept pace with the times. The Tasmanian Exhibition, which is to be opened on the 14th October next at Launceston, will afford to the people of the colony, and the many thousands who visit Tasmania in the summer, an opportunity of noting and comparing her industrial progress with that of other exhibiting communities. And it should be noted that, in view to Tasmanian mining development, a special opportunity is given for the exhibition of every variety of mining machinery and appliances.

As far as was possible, in the time allotted to me, I have roughly sketched Tasmania's recent economic development, present position,

and future prospects. I am afraid that I have been discursive, without having exhaustively treated anything but my audience. But I trust that you will make generous allowance for one who, being full to overflowing with his subject, is required to place it before you in thirty or forty minutes. If it were a story of the Sinbad the Sailor order I had to inflict you with, there would be no difficulty in fitting my narrative into any given space of time, but that is not so easy when one deals with facts and the financial history of a country in which one is very deeply interested.

Recapitulating my very dry and far from comprehensive description I may say, briefly, that I have shown, or endeavoured to show, how in good and evil times alike Tasmania, during the last ten years, has been making steady and solid progress; how, in response to the newly awakened life on her west coast, she has made an advance in her revenue and resources that may fairly be considered permanent. How, with the exception of whaling, which may be yet revived, her industries remain to her, or are being expanded or added to; how new industries are opening to her, and more than all, and for the benefit of my financial friend, how Tasmania is well within her borrowing powers, and may safely be trusted with some millions more of English money.

Tasmania must prosper if the eternal fitness of things is to be observed. The garden colony as she is called, and justly called, has been so richly endowed by Nature, that anything like failure in her career would be a hideous anomaly. Gifted with a climate that is second to none in the world; with a soil that is, as to a large part of it, wonderfully fertile; with scenery as various as it is exquisitely picturesque; with the promise of abundant mineral wealth in gold, tin, silver, iron, coal, bismuth, asbestos, &c.; and, beyond all, with a people kindly, honest, and sober. Gifted thus, Tasmania can hardly have any other destiny than a highly prosperous and happy one. There is no criminal class there to create anxious social problems or weaken the force of labour, no pauper class to waste the fruits of labour; the drones in the hive—now a peculiarity busy one—are few and far between. The community is one of workers, all of whom are contributing their share to the well-being of the commonwealth, all of whom may justly say—

“‘Tis not in mortals to command success,
But we'll do more, Sempronius—we'll deserve it.”

DISCUSSION.

The CHAIRMAN expressed his regret that the Earl of Aberdeen had been prevented from presiding on that evening, and, in inviting discussion, remarked that some fifteen years ago, when the silkworm disease was rampant in France, some eggs were sent out to Tasmania, to ascertain if healthy seed could be produced there, as it was found that in some parts the mulberry tree grew luxuriously. The result was so favourable, that the new seed was sent back from there to be reared again in France. Unfortunately, in crossing the line they were subjected to considerable heat, and many were destroyed; but those which arrived safely were very healthy, and it was evident that could they all have been transported safely, as they now could in refrigerating chambers, Tasmania could have supplied France with all the silkworm grain they required.

Mr. GRIFFITHS said he knew nothing personally of Tasmania, but he represented the company which had sent out a good deal of English capital to endeavour to develop some of the riches referred to in the paper. The mineral which came to his hands before it went to the Crystal Palace to be exhibited, was of a perfectly astonishing character, and far exceeded in richness the assays of bulk samples mentioned by Sir Edward Braddon; some from the Mount Zeelan field yielding over 400 ounces to the ton, and over £25 a ton had been realised by some of the samples. This company had 500 acres of land, on which nineteen lodes of silver lead had been discovered, and he was quite sure that any company in the north of England would be very well satisfied to work one lode such as was mentioned in a recent letter, of twelve feet wide. It would be amply sufficient to yield good returns, without reckoning the other eighteen. The most important point was one to which Sir Edward had not referred. It was most important for the sake of Tasmania and the mining industry that the railway up to Dundas, which it seemed to him was hanging fire, should be completed at once. The mining companies there were offering the navvies far more money than the contractors, and the latter suffered, consequently, from want of labour; but it seemed to him that in so doing these companies were cutting their own throats, as they had to pay such enormous sums for getting their machinery up to the mines, and the ore down to the port. He should like to know if any steps were to be taken to insist on the contractors finishing the line by the specified time.

Mr. WALFORD said he should like to ask a question with reference to the deputation which lately waited on the Government respecting the construction of the railway in continuation of the Derwent Valley Railway. He understood that one member of the deputation, who, he believed, came from Melbourne, said, that if the railway were made, the Melbourne people would be ready to invest over

a million of money in the silver fields of the west coast. Of course, no Government liked to spend money on railways without seeing its way to paying the interest; but it seemed to him that a practical way of constructing these railways would be to impose a small income-tax on the net profits of the mining companies which would be benefited by them. No doubt they would produce very large dividends and as the railways would be constructed for their convenience, it seemed only fair that they should contribute something to their cost. Instead of having to take all their plant to the west coast, and transport at Hobart, and again at Strahan, they could send it direct, which would be a great convenience, and effect a large saving.

The CHAIRMAN said he thought it would hardly do to raise the question of an income-tax in a new country like Tasmania, or to tax one particular industry.

Mr. J. S. O'HALLORAN (secretary, Royal Colonial Institute) said his acquaintance with Tasmania was very limited, as it only extended over a few months, when he escaped from the summer heat of the Australian mainland to enjoy the balmy breezes of one of the most perfect health-resorts on the face of the globe. He could never forget the charm of its climate, the beauty of its scenery, or the kindness and general hospitality of its people. His time was passed amongst the gardens, orchards, and hop-plantations of the south, and the fertile fields and rich pastures of the north-west, and his affections were fairly divided between the two. He was forcibly impressed that a colony with such a soil and such a climate could not fail to progress; and its recently developed mineral wealth has crowned the edifice. In the comparison which the reader of the paper drew between the relative productiveness of Canada and Australia, it should be borne in mind that the former mainly relies on the produce of her fisheries, forests, and agriculture, whereas unexampled riches have, since the discovery of gold, been poured into the lap of Australia, which possesses, in Queensland, the greatest gold mine extant, in New South Wales the greatest silver mine, and in Tasmania the greatest tin mine. The speaker could not say he was impressed by the energy of the people of Tasmania in his time, and, in Sir Edward Braddon's description of Mrs. Cairns's oyster-shop, he thought he detected a little of the old leaven; but it was satisfactory to know what a complete change had taken place in that respect, and that prosperity is now advancing by leaps and bounds. As regards the debt of the colony, which amounts to about £5,000,000, it must be remembered that the bulk has been expended on reproductive works, although something like £500,000 had been applied to public buildings, which can hardly be so termed. He happened to hold a few Tasmanian bonds, and considered them an excellent investment. In conclusion, it had always

been his ambition to renew his acquaintance with that beautiful island which Sir Edward Braddon so well described, for he could not conceive a more attractive country in which to make one's home. He ventured to hope that, in course of time, the existing fiscal arrangements might be somewhat modified, and that in the halcyon days when Australian federation shall have become an accomplished fact, the existing Customs barriers which now interpose between the sister colonies will be swept away.

SIR EDWARD BRADDON said he was happy to be able to answer Mr. Griffiths' question conclusively. The railway would be finished in June or July; at any rate, it had been determined by the Minister of Lands and Works, that if by June the contractors had not completed the work, the Government would take it over and complete it. The explanation Mr. Griffiths had suggested of the delay was, no doubt, correct; the mine owners not properly regarding their interests, had drawn the contractor's labourers away from him, paying 12s. where he had been paying 8s. or 10s., and so weakening his strength. With regard to the line from Hobart to Mount Zeehan, by an extension of the Derwent Valley Railway, he was sorry to say he could not speak so hopefully. The suggestion made by Mr. Walford was brought forward in the last Session of Parliament, and most emphatically rejected. Since then, the Minister responsible for railways had been making trial surveys on three different routes, all of which were recommended for railway communication between some centre, either Hobart or Launceston, and the west coast; but, more recently, apparently, the line of those who were eager to make the west coast a success, had been rather to do so by improving the Bar at the entrance of Macquarie Harbour than by any other means. That seemed to be thought more practicable at present, though the cost was likely to be some £180,000, according to Mr. Napier Bell, as against £600,000 for extending the line by the Derwent. The suggestion for taxing the mine owners in order to construct the line, could be made much more safely here than in Tasmania, where anyone who brought it forward would be very likely to get into hot water. He was grateful to Mr. O'Halloran for speaking kindly of the colony, as all who knew it must speak, though he seemed to be under the impression that it was a sort of sleepy hollow. He might assure him that times had changed, and that if some of the old leaven still remained, it was confined to the matter of fish. He had also rather questioned the soundness of his comparison between Canada and Australia, on the ground that the wealth of Canada was mainly drawn from fisheries and agriculture. But wealth from any source was ultimately represented in £ s. d., and he had given the figures showing the superiority in the aggregate earnings, and earnings per head in Australia. The actual value of the agricultural produce in Australia was £76,000,000, as against £58,000,000

for Canada, which was said to be a specially agricultural colony. He did not see that there was any hope of a reduction in the tariff from the Australian federation, which he feared would rather tend to raise it. But even then he hoped Tasmania might still pose before the world, as it did now, as the colony where taxation per head was lower than anywhere in Australasia.

The CHAIRMAN then proposed a vote of thanks to Sir Edward Braddon for his very valuable paper, which he hoped, through the *Journal*, would have a considerable influence on public opinion. He feared the whale fishery of Tasmania would not be restored, for the same reason that kept the Nantucket and New Bedford fishermen from sending out their fleets, viz., that the whale was becoming extinct. The fisheries on the coast were a different matter, for it had been shown that around the coast of Tasmania there was a vast source of wealth as yet untapped. Shipments of salt fish were being made from Newfoundland to Sydney, especially during the Lenten season, which might just as well be supplied from Tasmania, if they would only catch the fish and cure it in the same way. He hoped one result of the paper would be that some of the thousands of tourists who went annually to Australia and New Zealand would turn their attention to Tasmania, and see what a magnificent country there was there. As a friend of his lately said to him, when admiring the scenery of the north of Scotland, "Yes, it is very pretty, but it is nothing to Tasmania."

The vote of thanks was carried unanimously, and the meeting adjourned.

APPLIED ART SECTION.

Tuesday, March 24th; Sir HENRY DOULTON in the chair. The paper read was "The use of Cloisonné for Decoration in Ancient and Modern Times," by CLEMENT HEATON.

The paper and discussion will be printed in the next number of the *Journal*.

Miscellaneous.

MINING IN QUEENSLAND.

The last annual report of the Department of Mines, Queensland, is dated 22nd March, 1890,* and is for the year 1889. It speaks of mining as a steadily developing industry in the colony (though subject to fluctuations in working in consequence of

droughts), being now carried on under improved mining Acts, and under the supervision of four district inspectors, and many "wardens" and "mineral land Commissioners." Their several reports are included, together, at the end (p. 125), with the report of the mineralogical lecturer, who is a peripatetic teacher. The report in chief, addressed to the Minister for Mines, is signed Glen Cameron, Acting Under Secretary. It is not the custom to number these annual reports, but this is probably the twelfth. In the list of governments, as given in the Queensland "Year-book," a secretary for public works and mines first appears—8th January, 1884—Mr. (now Sir) Thos. McIlwraith, and in various tables in the report the "yields" are lumped together "down to end of 1887," and from that date they are given regularly for each year.

The report itself refers largely to the influence of recent legislative enactments, and being officially addressed to those who are acquainted with previous reports, it contains, with the exception of comparative statistics, no historic references in respect to mining.

It may help to show more clearly the advances made in mining industry to give some figures taken from the Queensland "Essays," prepared for the Colonial and Indian Exhibition of 1886, and the last edition, 1890, of the "Handbook for Emigrants."* It was in 1859 that Queensland (whose subdivision is now under consideration) was separated from New South Wales, as Victoria had been in 1850, both of which Colonies were previously portions of the undefined New South Wales Colony of 1788, with 29° S. and 129° E. as its boundaries (except for a quadrilateral of 3 deg. each way in S.W. corner, which is included in South Australia). Queensland has an area of 668,497 square miles, or five and a-half times that of Great Britain and Ireland, though the population, according to the 1888 estimate, is but 387,460, not an eighth that of London alone. It appears that coal was known to exist from the time of the first settlement, but it was not till 1849-50 that any attempt was made to raise it for commercial purposes. Up to 1882, the only worked fields were those in the basins of the Bremer and Brisbane rivers. More recently, the Burrum Field, north of Maryborough, has furnished an output of importance. These fields are of paleozoic age, and are classed with the true carboniferous. South of 26° S., and extending S.E., are fields of a far more recent mesozoic period, called the carbonaceous formation, and believed to be of the same age as the Indian coalfields.

Gold was first known to exist, in 1858, in the neighbourhood of Port Curtis (24° S.), and, soon after, at Canoona (about 20 miles from Rockhampton). The first "rush" of would-be gold-finders, though succeeded by much disappointment, led to the

* 1890. Queensland. Annual Report of the Department of Mines, Queensland, for the year 1889. Presented to both Houses of Parliament by command. Brisbane. By authority: James C. Peal, Government printer, William-street (C.A. 64, 1890).

* "Handbook for Emigrants to Queensland." By authority of the Agent-General for the Government of Queensland. London: Lake & Sison, 5, Victoria-street; 1890; pp. 54, and map.

foundation of workings, patiently continued, and which founded the now prosperous Rockhampton district. In 1868 the Gympie gold field was discovered, about 20 miles from Laguna Bay (26° 30' S.). A special feature of interest here is that the gold is found in sedimentary rock, grouped as Devonian, and in which deep mines, some over 1,450 feet, have been sunk. More recently, small fields, also in Devonian, have been found around Warwick (28° 20' S., 152° 10' E.). The gold fields of Northern Queensland have proved to be, in extent and richness, superior to those of the Central and Southern divisions. Gold has now been found to exist, and nearly every part of the colony, though only the older known fields are as yet systematically worked.

Copper appears in the tables of previous reports with 1 ton raised in 1860, 49 tons in 1861, reaching 2,000 tons in 1864, and fluctuating between 9,033 tons in 1868, and 326 in 1880.

Tin first appears in the tables in 1872, antimony in 1873, and silver in 1879. In 1874, 1 ton of silver is recorded, but the next four years are blank.

The figures given in the report of amounts raised during 1889 are:—

Gold, from quartz.....	728,816 ounces.
„ alluvial.....	10,287 „
Coal	265,507 tons.
Tin.....	3,033 „
Copper	1,079 „
Silver and lead.....	1,104 „
Antimony.....	58 „
Bismuth	52 „

A table on page 11 shows the relative amount of gold raised during 1889 in Queensland and in other colonies. Omitting here the hundreds, and giving only the thousands of ounces, the order comes out—Queensland, 739; Victoria, 614; New Zealand, 203; New South Wales, 113 (nearly); Tasmania, 33; South Australia, 20; West Australia, 15.

With some fluctuations about 1882, the lowest point reached (172), the yield of quartz gold has gone on increasing from 188,000 oz. in 1877, to 728 in 1889; while the alluvial has decreased from 164, in 1877, to 10 in 1889. It is curious, in connection with these figures, to notice that the number of European quartz miners has fallen off 529 during the year, while the alluvial have increased 133. This probably is due to finding fresh alluvial fields in remote parts of the colony. The total number of gold miners has dropped from 9,491 to 8,955 during the year, though the gold yield has increased 257,459 oz. on the previous year. This may be perhaps accounted for by machinery improvements, and by the fact that, of the 739,000 oz. of total for the year, Mount Morgan* alone

contributed 323,500 oz., Charters Towers district being in the second place with 28,000. Among other figures given are the following:—There are in the colony 2,212 distinct reefs proved to be auriferous, and the various gold workings cover a total area of 15,169 square miles. There are employed in gold working 497 steam-engines (6,526 horse-power total) and 164 crushing machines. The returns of ozs. of gold per ton are given in averages, the highest being of the Rockhampton district, 4. ozs. 4 dwts.; Palmer, 4 ozs. 1 dwt.; Nebo, 3 ozs. 7 dwts; down to Gayndale, 9 dwts. only; the total average coming out at 1 oz. 17 dwts. The prices fetched by gold per ounce ranged from £4 2s. (Rockhampton) to £3, Croydon being exceptionally low at £2 11s. 5d. For a series of years the averages come out £3 10s. The amount paid to the State Revenue for licenses brought £25,248 in the year.

Some curious facts, illustrating the causes of fluctuations in returns, are given, *e.g.*, in the Croydon district the serious drought prevented the quartz raised in 1888 from being crushed; and even some raised in 1887 could not be crushed in 1889.

In order to answer in a satisfactory way what may be expected to be the future of deep gold mining, the Government has made an addition to its diamond drills. It possessed three, but these were of use only to the 1,000 feet depth. The have now one, manufactured in Melbourne at a cost of £2,230, which is estimated to work to 3,000 feet.

In the "Gold Wardens'" reports of districts under their charge, there are given details of particular mines, of machinery of different kinds, of accidents, of the details of crushings, the name of each claim, population, health, crime, &c. These reports show, according to districts, great diversity in advance, and in falling off in the amount of work achieved and the results in money return. These occupy from p. 25 to 75. From p. 75 there follow the reports of mineral lands commissioners, as distinct from the gold workers; and one of the reports alludes to the prospect of copper mining taking high rank in the colony. The reports of inspectors deal with condition of mines in regard to safety, ventilation, &c., and show that, though the mines are comparatively recent, the supervision exercised in the mother-country is closely copied.

The legislative points touched on in the report proper include "The Crown Land Acts' 1884 to 1886 Amendment Act of 1889," one great feature of which is the removal of the disability from which miners laboured, by coming in contact with pastoral leases, on questions of compensation, which was often claimed at exorbitant rates. It also removes restrictions unintentionally imposed by the wording of the 1884 Act.

"The Mines Regulation Act, 1889," improves the safety of mines, as some had "enjoyed im-

tion; and that, on the chemical precipitation of these, they consolidated into the ferruginous stone now worked for the included gold.

* The Mount Morgan mine is exceptionally rich in gold that is quite pure, and exceedingly finely divided in the stone. The opinion of the Government geologist, Mr. Jack, is that Mount Morgan was in past geological ages a hot spring (a sort of geyser), which held gold and other minerals in solu-

munity from official supervision." No application had been made to convert coal "licenses" into "leasehold."

Changes have been made in regulations for prospecting parties. Instead of being furnished with horses, equipment, provisions, and firearms, the sum of 30s. a week per head is to be allowed, and the parties are not to be more than five or less than three. During the year, 25 parties prospected, but with only negative results. There are, however, already more mineral fields known than are being fully worked.

UTILISATION OF SAWDUST AND SHAVINGS.

These practically waste substances are turned to account by M. Calmant, of Paris, for the production of a finely-divided vegetable charcoal, which is intended to be applied for the removal of unpleasant flavour in ordinary French wine, otherwise unsaleable as wine, although suitable for distillation. The charcoal is also available as a filtering medium, especially in distilleries, where it is said to be capable of filtering forty times its volume of alcohol, whereas the vegetable charcoal of commerce, gradually becoming scarcer and dearer, and which requires grinding and often re-carbonisation, will only filter about three times its volume.

If not already separate, the sawdust of hard and soft woods must be separated, because the former requires a heat of 700° Centigrade, whereas 500° Centigrade suffice for carbonising the latter. Carbonisation, which lasts about an hour, is effected in fire-clay, plumbago or cast-iron retorts, of about 600 cubic inches capacity. But, previous to this process, the sawdust must be sifted, first through a coarse screen to remove splinters and extraneous matter, and then through a fine sieve, which only permits passage of the actual wood dust with the adherent calcareous matter. The product of carbonisation must again be sifted to get rid of this calcareous matter which has become detached during the process, when it will, if the operation has been carefully performed, resist the action of hydrochloric acid. Shavings of either hard or soft woods, also kept separate, must be subjected to preliminary treatment (which consists in a beating, to detach the adherent dust, and then a high degree of compression in a hydraulic or other press), when they are carbonised in the same manner as the sawdust, and then ground in a mill to reduce them to the same degree of fineness. Great care must be exercised to prevent the charcoal absorbing moisture from the atmosphere, and with this object it must be enclosed in air-tight recipients until required for use.

General Notes.

RECEIPTS OF PARIS THEATRES IN 1890.—According to a report in the last number of the *Bulletin de Statistique et de Legislation Comparée* the gross receipts of all the Paris theatres amounted last year to £920,536, as compared with £1,285,556 in 1889. It must be remembered, however, that the latter was the Paris Exhibition year, when the receipts of various places of amusement would naturally be higher than the average year. In 1888 they amounted to £920,280. During last year the largest amount realised by any of the places of amusement in Paris was £114,776—taken at the Opera-house, a building capable of holding 2,200 persons. The next in order of importance was the Théâtre Français with £75,978; and after it came the Hippodrome with £70,004; the Porte Saint Martin, £59,292; the Opera Comique, £56,652; and the Variétés, with £46,672; £39,352 were taken at the Vaudeville; £35,276 at the Gymnase; £35,858 at the Palais Royal; £28,796 at the Bouffes Parisiens; and £29,706 at the Cirque Franconi.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

APRIL 8.—A. P. LAURIE, "The Durability of Pictures Painted with Oils and Varnishes." W. HOLMAN HUNT will preside.

APRIL 15.—WM. TOPLEY, F.R.S., "The Sources of Petroleum and Natural Gas." PROF. CLEMENT LE NEVE FOSTER, D.Sc., will preside.

APRIL 22.—SIR GUILFORD MOLESWORTH, K.C.I.E., "Bimetallism." SIR WILLIAM HENRY HOULDSWORTH, Bart., M.P., will preside.

APRIL 29.—WILLIAM ROBINSON, "The Use of Petroleum in Prime Motors."

MAY 6.—J. E. H. GORDON, M.Inst.C.E., "Recent Development in the Public Distribution of Electricity."

MAY 13.—PROF. J. J. HUMMEL, "Fast and Fugitive Dyes." SIR OWEN ROBERTS, Treasurer of the Society, will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

Journal of the Society of Arts.

No. 2,002. VOL. XXXIX.

FRIDAY, APRIL 3, 1891.

All communications for the Society should be addressed to
the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

INDUSTRIAL HYGIENE.

Under the Benjamin Shaw Trust, the Council have offered two Gold Medals, or two prizes of £20 each, to be awarded on the recommendation of the Executive Committee of the Congress of Hygiene and Demography (1891), for such inventions or discoveries of date subsequent to 1885, exhibited at or submitted to the Congress, and coming within the terms of the Trust, as may be considered worthy of awards. Under the terms of the Trust, the prizes are offered "for any discovery, invention, or newly-devised method for obviating, or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

Further particulars as to the method of application for these prizes will be published later on.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, March 24th; Sir HENRY DOULTON in the chair.

The paper read was—

THE USE OF CLOISONNÉ FOR DECORATION IN ANCIENT & MODERN TIMES.

BY CLEMENT HEATON.

The decorative art described as *cloisonné* has been so lost sight of in modern times that, except for the works of art brought from the

East, it might be considered as practically non-existent. Even at the present day the word *cloisonné* gives no idea at all to the majority, and to the greater part of those who have some idea of what it is, it recalls to mind only the vases of China and Japan. It is, therefore, somewhat surprising to find that it is one of the very oldest forms of art, and that it has no unimportant and local history, but has been widely spread, and has, moreover, given rise to, or greatly influenced other arts more important than itself.

To trace its history I shall have to make a wide though necessarily brief review, but I shall do so from the standpoint of an artist and craftsman, and not as an archaeologist, and with the view of showing what place *cloisonné* has held as an art in bygone days, and how it can be used now.

But before tracing its history it may be well to make clear the exact nature of the work. The French name "*cloisonné*," meaning "enclosed work," gives at once the idea of its leading characteristic, which is the use of a dividing line, edge, or *cloison*. This *cloison* forms a cell in which coloured material is held, and its surface forms a neutral line between the various colours. This edge may evidently be produced in several ways. Thus a ribbon of metal may be bent and soldered down to a ground, which gives a *cloisonné* proper; if, instead of a ribbon, an ordinary round wire be used we get a filigree, or enamelled filigree if enamel is introduced. Again, a surface of material such as metal, stone, wood, &c., may be dug into, and the ground cut away, leaving the edges standing. This gives a *champlevé*. The *cloisonné* gives as result fine even lines, and a delicate effect; the *champlevé* strong variable lines, and a rich effect. In thin, ductile, or plastic material, hollows and edges may be formed by depressing and elevating the surface, the hollows being afterwards enamelled; or moulds may be made with cells prepared to receive colour filling. In the case of earthenware, fillets of clay can be attached to the ground, and enamel floated between the lines.

These various ways of forming an inlay with dividing lines to fields of colour, may be all classed under the system of *cloisonnage*. Other forms of inlay approach very closely to this work, as *intagliatura*, *niello*, *intarsia*, damascening, and *boule* work. And the decorative effect of the *cloison* has often been copied in enamelled earthenware and painting.

Into the spaces so formed colour is introduced, and this in a variety of ways. The

oldest form is the insertion of pieces of fine stone, &c., cut to shape, and inlaid or *enchassé*; coloured cements and encaustics were also used at an early date; and lastly, long after the system of *cloisonnage* had been established—probably over a thousand years after—vitreous enamel was used as a filling. The use of enamel, then, is far from being indispensable to produce a *cloisonné*, and *cloisonné-enamel* is only one section of the art, as vitreous mosaic is of mosaic.

The artistic effect produced by any of these methods is essentially decorative. It yields a flat and coloured surface, with the colours divided by lines of some metallic or neutral material; and this division and blending of the colours is so eminently beautiful, that it has influenced design in other arts to a remarkable extent.

It is natural that personal adornments, and the embellishments of arms and implements, should have been the first things to which civilised people have turned their attention; and it seems that the blending of precious metals with colour, in the form of *champlevé* or *cloisonné* has been one of the earliest products in art; and this, as the most precious work known to the possessors, has afterwards been copied in other materials, and has influenced early forms of both painting and architectural ornament.

We must therefore clearly distinguish between *cloisonné*, as limited to jewellery and as applied to decoration, either in the form of inlay, or the system of design based upon it.

Some few years ago a piece of Damascus enamelled work suggested to me that *cloisonné* would form a beautiful medium for the decoration of walls, and since that time I have worked out a system of *cloisonnage* for this purpose, and have lately been able to trace the use of it for decoration in ancient times as I will describe.

The atmospheric condition of modern life in England, especially in towns, demands the use of a decoration of a permanent character, and the system of *cloisonnage*, of all materials for decoration, affords that sense of unity of effect so necessary in decoration, as its structure, while fully in evidence, enhances and assists the beauty of the work and does not detract from it. The division of colours by a line of neutral material, especially when of metal, is of the greatest artistic value, and blends and separates them at the same time; thus the contrast between the curved sinuous line and the field of colour is most agreeable. The use

made of it by the Greeks, and in the Persian friezes in the Louvre, is evidence enough of this.

I have been working on *cloisonné*, and using an encaustic filling.* The *cloisons* are usually about a quarter of an inch deep, and are soldered on to a metal ground, and the encaustic, hardened by the addition of 75 per cent. or more of marble-powder, is pressed into the cells, and compressed into a hard mass, and finally polished down. Plates as large as 8 feet by 3 feet can be made by this method, and any degree of fineness or vigour arrived at. Plates can be placed side by side and so any extent of surface covered. The colour is given by the addition of pigments, which permeate the mass of encaustic while being made.

But where encaustic is not suitable, other means of arriving at the result may be adopted; and with enamel, encaustic, glass inlay, cement, and *béton* of coloured marbles, a range of materials is at hand to meet the exigencies of varying conditions. In some cases, the thin even line given by the *cloison* may be an objection, and, in that case, *champlevé* would be substituted, or parts may be in one and parts in the other. As I have already shown,

* I was led to attach value to encaustic from the following testimonies:—

Linton writes—"So important was wax considered by the Greeks as the chief protector of their works of art, that the word 'wax' was frequently used to denote the picture itself—it was used mixed with resin."

Prof. Triglay writes—"Greece might still boast of the masterpieces of encaustic from the hands of Polygnatus of Thasos, had they not, after centuries of admiration, become the subject of envy to the Roman Praetors, who caused them to be transported."

Montabert gives a list of colours which are not permanent in oil, but which can safely be used in a wax medium.

Sir Charles Eastlake writes—"The tendency of wax, when mixed with resin, is to check the tendency to glow when exposed to the highest natural temperature, and to prevent the cracking of the surface. Wax itself has no tendency to crack."

Mr. Standage said he considered the permanency of colours to be increased a hundred-fold when protected by an encaustic medium.

And these opinions seem fully borne out by examples. Linton quotes the case of decoration in subterranean chambers, which were as perfect when discovered in the last century at Stabia, as when executed, nearly 2,000 years ago.

Statues discovered on the Acropolis at Athens, in 1886, retained their painted ornaments in encaustic after nearly 3,000 years' burial. The colour separated off from the marble when exposed to the air, but the pigment was still preserved.

Mr. Flinders Petrie has discovered, recently, at Hawara, many examples of encaustic painting, and he examined the history of its use. He says it has an advantage over oil, in that wax allies itself with all colours, and does not crack or flake off, and preserves the material on which it is laid against dust and damp.

The whole surface of the marble in buildings was covered by the Greeks with wax, to give warmth of effect, and this has had much to do with preserving the marble.

cloisonnage is an art with various renderings; and one has to use it with a proper discrimination of what is fitting for any given occasion. But this necessitates a long apprenticeship, and much unfruitful experiment, before sufficient experience has been gained; and advance has only been made by meeting a long succession of difficulties, many of which were technical and mechanical. Many more were questions of design and artistic treatment, and I have pleasure in acknowledging the assistance received by me from the criticisms of Mr. Frederic Shields and Mr. Starkie Gardner, in dealing with these. In reviving an art such as this, one's knowledge grows from day to day; and I should like to say, that even yet, whatever has been done, does not demonstrate all that is possible, and must not be taken as a final expression of the art.

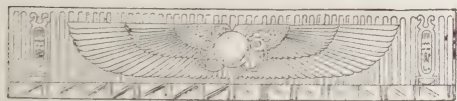
The facility for dealing with the metallic portions of the work has been largely increased by an association with Mr. Starkie Gardner's metal working and with the various means at our disposal, we are, therefore, again able to work on the lines suggested by the workers of the past.

HISTORY OF CLOISONNAGE.

EGYPT.

The history of *cloisonnage* begins on the banks of the Nile in the dim light of Egyptian civilisation. When Athens and Rome were yet unbuilt, the arts of working in metal were known in the land of the Pharaohs, and thirty centuries before our era *cloisonné* jewellery appears to have been already perfected, and its use was continued through several dynasties. A statue in wood, found at Memphis, and said to date 3426 B.C. has the eyes laid in hard material and bronze lines. The mummy case of King An-An-Teef in the British Museum is similarly treated.

FIG. 1.



EGYPTIAN CLOISONNE JEWEL.

Cloisonnage, among the Egyptians, was made not only in gold, but in bronze, stone, porcelain, wood, and ivory. The mere enumeration of the materials used, shows that it held no isolated place in their art. It entered indeed into the decoration of many kinds of work, and must have been held in the highest esteem.

The proof of this is found in the fact that it held the place of honour in the adornment of the dead. Nowhere were the dead so profoundly revered as in Egypt, where it was a current belief that the eternal existence of the soul, which so much occupied their thoughts, was connected with the conservation of the body. The ritual of the dead prescribed that certain ornaments should be placed with the deceased, and the pectoral was the chief of these. These pectorals remain in great number, and are in the form of hawks and other emblems, sometimes in *cloisonné* of gold, but mostly in *champlevé* of less costly material; and these, after remaining in the darkness and silence of the tomb while the long roll of history was being enacted, are at last exposed to view in our collections. The finest of these are at Boulaq, where that found on the body of Queen Aah-Hotep, dated 1703 B.C., is one of the glories of the collection. Another of great beauty, found in the tomb of Rameses II., the oppressor of the Hebrews, is at the Louvre, and there is a gold hawk in London.

Besides the pectorals, bracelets, necklaces, &c., were made in *cloisonné*, and the kings are represented as wearing such. The fine pair of bracelets at the British Museum are in gold and *lapis lazuli* and blue-lime cement, with figures modelled in low relief.

We find *cloisonnage* also worked in wood and ivory, which has been gilt. It was used for spoons, boats, and all manner of objects. There is a winged figure in Jermyn-street Museum, in wood, with inlaid wings.

The system was also extended to architectural decoration. The great hawks and winged lions over the entrances, as at Karnak, are cut out and coloured in a way that produces a *champlevé*, and the vertical coloured lines, so often found on the cornices are treated in the same way. It seems natural to suppose that these hawks, &c., were copied from the golden emblems in *cloisonné* jewellery worn on the person. And this the more that, in many examples, we find in the mummy cases at the British Museum, scrupulously exact imitations in painting of the different kinds of *cloisonné* jewels formerly on the mummy within. The eyes, too, of the painted figures are certainly often copied from the inlaid bronze eyes found in some examples, and this explains their peculiar drawing.

I mention this particularly, because it is the first instance of the influence of *cloisonnage* on ornamental design, and this has occurred again in other times.

At the British Museum are also found parts of stone columns treated as a *champlevé*, inlaid with coloured porcelain, and two capitals are in bronze, which are true *champlevés*, and have been inlaid with blue-lime cement, part of which remains. These may have been parts of the light wood and metal architecture represented in paintings, and in which the design is just that suitable for *cloisonnage*.

It is evident, therefore, that in Egyptian art, the oldest art in the world, *cloisonnage* was deeply seated, and I think much of the technique of Egyptian drawing will be found to be due to the fact that the artist was thinking of inlay, rather than looking directly at nature.

The use they made of it for capitals and columns is suggestive of what might be done again. Mr. Aitchison said the other day, "we especially want to give the new materials employed, particularly iron, some vigorous stamp of architectural beauty," and may it not be that by returning to the source which has already yielded so much, new ideas may yet be gathered, and that the masculine vigour of early art may yet have a lesson for us?

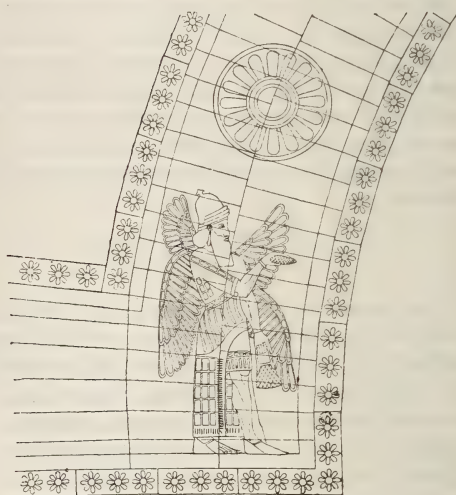
ASSYRIA.

If from the Nile we pass to the banks of the Tigris and Euphrates, we find the Assyrians and Chaldeans also making use of *cloisonnage*. Though the absence of tombs deprives us of any such record from actual remains, as in Egypt, inscriptions supply the void in great measure. It is sad to find these recount the ferocious cruelty of the monarchs, as well as their magnificence in decoration. We learn how captives were exposed before the great bulls and flung into the fosse, eaten by dogs, wild beasts and birds of prey, "to rejoice the great gods!" at the same time that we learn the magnificence and sumptuousness of the palaces. Mr. Charles de Linas, who has minutely investigated the history of *cloisonné* jewellery,* cites several inscriptions. It is recorded that in Chaldea statues were draped with gold incrustated with precious stones; and Mr. de Linas considers, as the result of his inquiry, that within the temples were plates of metal or stone, inlaid with figures in coloured stones, and that the figures on the exterior in enamelled bricks were copies of this inlaid work, the enamels representing the material employed—yellow, the gold;

white, silver; red, cornelian; blue, *lapis lazuli*, &c. The drawing of these figures is such as to lead me to think any other origin than that of inlay is impossible. The semi-circular frieze over an entrance arch at Nineveh, of which a drawing is given (Fig. 2), is an example of this.

The use of gold and precious materials was lavish; and this is the more easy to understand, when it is remembered that gold was valued in those early times precisely for its decorative qualities, and was not used for money, and that stores of this metal were extracted from every conquered foe. An inscription (604 B.C.) mentions a cupola covered with gold, and a temple enamelled and covered with gold.

FIG. 2.



PART OF FRIEZE FROM NINEVEH.

Enamel is recorded as having been stored up in the royal treasuries as a precious substance, and it would be interesting to know whence this enamel came.

If, from the inscriptions, we turn to the remains, we find represented in the wall-carvings, jewels, dagger handles, and other personal objects, and the sacred tree—so designed that they could certainly be executed in *cloisonné*; and types of design, which would be natural for such work, are found in ornament, whether it be embroidery, painted work, or enamelled brick. I cannot but think that here also, as in Egypt, the origin of much of the ornament is to be found in *cloisonné*. The records in the inscriptions of the use of metal, ivory, and precious stones in architectural decoration

* "Les Origines de l'Orfèvrerie Cloisonnée." A perfect orchard of facts.

is quite in accord with existing remains, though, of course, little metal work has survived destruction.

M.M. Perrot and Chipiez* show that wooden columns covered with metal were used in Assyria, and the volute is mentioned as originally being in metal. The only Assyrian columns discovered show a bulbous form of capital and base, in stone, evidently copied from a metal original, with raised *cloisons* as the only decoration. Place found remains of wooden shafts covered with bronze and gold scales.

Furniture was made in metal, and with great luxury, as in the Book of Esther we read of gold and silver furniture in the palace of the king. The bronze thrones, &c., at the British Museum from Van in Armenia, show numbers of cells made in the bronze for the purpose of a colour inlay, and ivory slabs were also let into spaces provided.

The stone pavement slabs under the entrance arches, which were of great size, were really a *champlevé* in stone. Three of these are in the Assyrian basement room. An examination of them shows the surface to have been cut away to receive a colour-filling, part of which still remains. M. Perrot considers the design of these more judicious and better conformed to the rules of art than the Roman mosaic. They are suggestive of the beautiful use which could be made of *cloisonné* for pavements at the present day. Two slabs were made in this way for St. Mary's, Stamford. Curved lines and the spiral predominate; and here, as well as in the painted work and enamelled bricks, I infer, has been derived from metal-work.

I have now only to mention the beautiful ivories from Nimroud. These were found in great numbers, and often repeated, and must have formed part of the decoration of the halls. Part of these come from Phœnicia, and they are of the greatest interest in connection with our subject, because they are evidently a continuation of the Egyptian tradition, and are of *champlevé* in association with relief. The spaces cut out have been filled in with *lapis lazuli* and other colours, and parts gilt, and the design is such as to suggest that they are derived from the metallic work. I shall refer to these again in speaking of Phœnicia.

But before passing westwards to Phœnicia, it will be better to continue the history in the East down to our own times, as Oriental art has really continued much on its original lines, and

has never lost sight of the true principles of polychromatic decoration. The East has been therefore a sort of reservoir of influence for Western art, which has again and again received a renewal of principles of decoration therefrom.

PERSIA AND THE EAST TO OUR OWN DAY.

After the overthrow of the Assyrians, the Persians kept up the traditions of enamelling on brick, and it is to them we owe the grand series of works in low relief and enamel from the palaces of Darius and Artaxerxes Mnemon at Susa, now in the Louvre. One of these friezes is twelve yards long by eleven feet high, in perfect preservation, with a procession of archers in profile, and bands of ornament. Another is a frieze of lions, with ornament above and below. Mr. Aitchison says of these that "they have not only enlarged the minds of every visitor in the Louvre, and have given an almost unique lesson in monumental colouring, but have also given an impetus to that beautiful branch of art, enamelled pottery. All the roofs of last year's exhibition at Paris were resplendent with colour, wholly due to the exhibition of these enamelled friezes."

Their effect is, indeed, of striking beauty—a harmony of soft blues, greens, and yellows, with a little white and dark brown. The whole treatment is that of a *cloisonné*, the outlines being fillets of clay, separating the enamel, and reflecting lines of light.

Cloisonné jewellery was in use in the 3rd and 4th centuries A.D., in the neighbourhood of Perim, and appears to have been a survival of the Assyrian tradition. In any case, the Græco-Bactrian armlet at South Kensington shows the use of gryphons very similar to the old Assyrian type of winged figure. At the present day a beautiful form of *cloisonné* is used for belts and horse trappings in Northern Persia—silver *cloisons* set with turquoise. In modern Persia, *champlevé* enamel has been in use, and in the tile work, as at Ispahan, the principle of *cloisonnage* is strongly marked.

INDIA.

In Indian art *cloisonnage* is fully in evidence. We find enamels of Jeypore of both *cloisonné* and *champlevé*, and the lac-inlaid brass work from Moradabad is a *champlevé* of a most beautiful kind. Jewellery is made of enamelled *champlevé*, and bowls and other large objects are also made in it at Kangra and Cashmir. A specially beautiful association of gold and enamel is made at Pertubghur

* "L'Art dans l'Antiquité."

for jewellery; saw-pierced gold plate being embedded on the clearest possible copper-green enamel. This system seems to have been copied in Venice. The Guthrie collection at the Indian Museum shows a series of examples of jade inlaid with gold and jewels. The work in copper and bronze shows the extensive use of the raised edge, and the same principle is carried into the architectural ornament. The resemblance between this and the Ionic Greek work is startling, and examination shows it is due to the principle being the same, while the design is different; the system in both being the use of a raised edge and concave surfaces. The Jeypore folio of architectural ornament fully illustrates this, and actual examples in the entrance court, especially the *façade* of a house from Bulandzhaha. Here we find, also, the use of pierced stone lattice work, which is so characteristic.

In Burmah the *cloisonné* principle is predominant, and the two cones from the Palace show the actual use of *cloisonné* and gems. But the principle is so coarsely applied, that it is of little further interest.

CHINA.

Passing to China, we find the principle has been introduced, and has struck deep root. It was perhaps imported with Buddhism from India, as *cloisonné* vessels were reserved for sacred uses. It was at its greatest development there about 1450, after which period it was somewhat neglected, but again came into favour under the Tai-thsing dynasty. The works of this period are paler than the earlier ones. It is said that one of the Emperors worked at it himself, as Louis XVI. did at lock-making. It was then entirely neglected, and was revived, through European demand, of late years, the traditions never having been quite lost.

JAPAN.

The Japanese received their tradition of *cloisonné* enamel through the Corea. While in India the tendency is to *champlevé*, in China and Japan it is as much towards *cloisonné*. The oldest Japanese works are decorative and vigorous in character, dark in colour, with green predominating. The *cloisons* are well marked, and the forms such as naturally arise in the bending of the metal lines.

Their modern work has been carried to a perfection, which I do not think possible to be surpassed, and which, from a technical point

of view, puts every other production of this work in the background. The delicacy is microscopic, and the mastery over the *technique* of the enamel really wonderful; but still we prefer the older works, and feel that the Japanese are losing the true value of the material, and, like the Limoges enamellers, seeking to make a purely decorative and ornamental art a vehicle of representation for which it is not fitted. On the other hand, they have worked out schemes of soft and neutral colouring, which show what possibilities are latent in the system for modern use. The latest developments are, the use of aventurine, and a scheme of design on a blue black background, which is one of the loveliest forms I have yet seen. This constitutes, the present day development of traditions which commenced in Egypt nearly 50 centuries ago, and which have been in use ever since. The little Japanese we lately saw at work in London is a modern representation of the ancient worker on the Nile, whose ashes have long mingled with the desert earth, but whose works yet remain.

Returning West, to pick up the thread where we left it at Assyria, we find the Phœnicians on the shores of the Mediterranean. They were allied with the Chaldeo-Assyrians by origin, and, as the great commercial *entrepreneurs* of the day, were in constant communication with neighbouring peoples, and copied their art and that of Egypt, and spread these mingled traditions in the West in the course of their trading. One of their centres, Cyprus, was the meeting-place of many currents, and here we find the art of Greece in contact with Eastern art. De Cesnola has here found a *cloisonné* bracelet, and enamelled filigree brooches of Phœnician work. This bracelet is in the Egyptian style, but with an Assyrian element introduced. This one piece is sufficient to show that they made *cloisonné*; and the ivories found at Nimroud, as I have already said, suggest by internal evidence that they were designed on the lines suggested by the metal *cloisons*.

The Phœnician stone capitals found at Cyprus, and illustrated by Perrot and Chipiez,* have motives borrowed from this ivory work, showing how stone forms were borrowed from the *champlevé*; and again, a very early type of Ionic capital, illustrated in the same work, shows a transition from these Cypriote capitals, so that it would seem as if the Ionic capital is based through this

* "L'Art dans l'Antiquité." Vol. III.

medium on the *cloisonné* jewellery. A parallel case is the sarcophagus found by De Cesnola, which shows a form of antefiscal ornament half-way between the ivory *champ-levé* and the later Greek form.

THE HEBREWS.

It will be remembered that Solomon had Phœnician workmen from Tyre when he was building the Temple. From the fact that the Phenicians used *cloisonnage*, we may infer that it would probably be used in the Temple; and from the descriptions, and from the fact that the Hebrew word translated "carve," means to cut or engrave (Smith's "Dictionary of the Bible"), in the accounts given, I am led to think it certainly was used there; but as no remains exist, it would take too long to pursue speculations on this subject.

GREECE.

If we pass across the Ionian Sea to the sunny land of Greece, we find evidence of the *cloisonnage* system being known to the Greeks. In the archaic work of Mycenæ and Tiryns the peculiar spiral ornament found on the stone pillar at Mycenæ and other places, which Fergusson regretted we did not know more of, has now had its origin cleared up by the discoveries of Schliemann. It is evidently a copy in stone of a purely metallic ornament.

Mycenæ was a powerful fortress on a rock rising out of a level plain, and the royal residence of a warrior race, who loved architectural beauty and personal adornment. Armour, weapons, and utensils were of precious material, and most delicate and graceful workmanship. The palace was rich in colour, bronze, and alabaster.

The tombs of the royal occupants have held the treasures now well known, which are largely of gold and bronze, and here we find the spiral lines and raised edges from which the ornament on the stone work was derived. A sceptre in *cloisonné* of gold, inlaid with rock crystal, was also found.

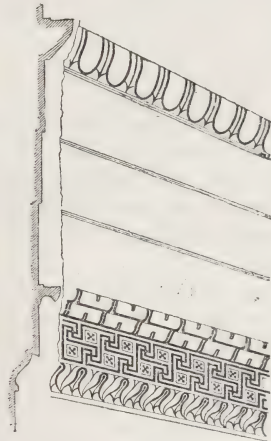
The timbers of the buildings and the doors were encased with plates of bronze, and slabs of alabaster, inlaid with glass and richly carved, decorated the vestibule at Tiryns. Metal plates were also used to cover the vault of the tombs of Attriis and others. It is generally admitted that early Greek work was largely metallic, and the descriptions in Homer refer to the use of metal decorations. This use of metal led to the use of an edge rather than to relief.

In the fully developed Greek art we find the goldsmith's work still carrying out the same idea. It is of filigree work and *repoussé*, with enamel colour used with the greatest restraint, and just enough in quantity to give contrast to the gold. The work is so refined and beautiful, so right in scale compared to the human figure, that one cannot imagine it to be surpassed; and we can guess what it must have looked like when adorning some lovely Greek. In later work this restraint and refinement disappear. Enamelled filigree is still made by hereditary Greek smiths, who have kept up the tradition of the ancient Greeks.

The bronze work shows the constant use of an edge in contrast with broad, rounded surfaces, and damascening with silver and gold.

If from the metal work we turn to the Greek architectural ornament, we find the same feeling prevailing. I have already mentioned the

FIG. 3.



GREEK ENTABLATURE SUGGESTING CLOISONNE TREATMENT.

Ionic capital and the antefiscal ornament. In Ionic work, as at the Erechtheum, we find further evidences of the *cloison* principle. The plaited moulding of the capital was inlaid with coloured glass, as shown by Hittorf. The whole of the carving shows the use of the edge, as, for instance, in the frieze, where the flower ornament is an edge about half an inch wide, on a sunk ground, and this edge is again grooved on its surface, so as to produce yet other lines. The same character marks the egg and dart, and other mouldings above the frieze. If these were gilt, and the background coloured, as seems was the case, the effect would have been

that of a *cloisonné*, full of sparkling light and colour.

In Doric work the painted ornaments on the moulding are, in design, quite a *cloisonné*. I have drawn out full-size mouldings from the Propylæa and the Parthenon, from data given by Mr. Penrose in his work, and a part of the ceiling design, and it will be seen how the sumptuousness of the colour* is still full of grace and refinement, due to the gold dividing lines. These coloured parts, far from hiding the beauty of the marble, would add to it by contrast. Whatever may be thought of Greek polychromatic decoration, which has been the subject of so fierce a controversy, one thing is certain, that they did use colour at the finest period, and they designed it on the principles of *cloisonnage*. If at a later time they discontinued it, it was contemporaneously with a decline in their art.

All through Greek work the edge seems to be used in contrast with the broad surfaces, and I cannot but think the Greek artists were fully conscious of the value of this system. The flutings of columns, the mouldings, and even the drapery of the figures (which is raised into ridges and deep grooves) all carry on the same idea. Mr. Elsey Smith says, "One can still sit in front of the Propylæa at Athens, and watch the sun as it creeps round, gradually bringing out new lines of light."

If this is so, does it not offer suggestions for our Renaissance work of to-day. For instance, may not the concave treatment be the right treatment for carved work for our London atmosphere? Relief work requires to be clean, and to have a fairly good light to be readable; but edge-work, no matter how dirty is the surface, how dull the light, will hold its own. Evidence of this may be seen by a comparison of the carved panels in the Foreign-office and Treasury. It is remarkable that, while particular *motifs* of Greek ornament have been copied *ad nauseam*, the principles on which the Greeks worked their ornament should have been so little used.

And, again, in the interior of large public buildings, where the relative value of colours must be soon destroyed by dirt, and made to approach uniformity, how greatly it would enhance and preserve the effect if the system of design were based on *cloisonnage*, so that

a delicate weaving of gold lines through the whole would remain long after the purity of these colours was lost, and render the whole intelligible.

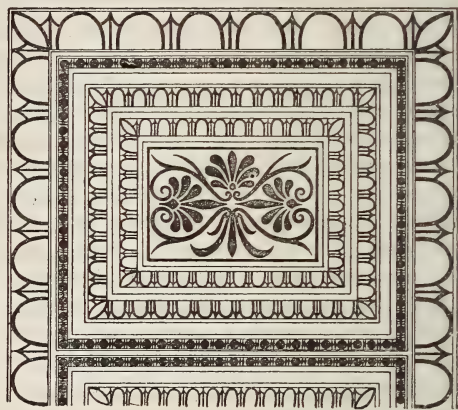
And bands of *cloisonné* could be used in conjunction with marble, as suggested by the mouldings of the Propylæa. The use of *cloisonné* with sculpture, as a means of introducing colour without loss of preciousness, is suggested by the coloured bands of the Parthenon.

I must now briefly continue the history after the Greek epoch.

ROMAN.

In Roman work, we come upon a gap in the history. For the first time, so far as I know, in the history of art, the edge system is lost, and gives place to rounded relief ornament. There is consequently a marked contrast between Roman and Greek ornament. May the

FIG. 4.



PART OF POMPEIAN CEILING.

explanation of this be found in the fact that hitherto architectural ornament had been mainly flat polychromatic work, used in association with figure relief, and that under the Romans colour and figure ceased to be generally used? However, traces of the *cloisonnage* system still remain here and there, as at Pompeii, where large numbers of borders are based on a type of design formed of yellow lines on some dark colour. Mr. Gardner showed us, the other evening, that quite important pieces of *champlevé* enamel were made for the Romans by the British, which goes to show that the Romans appreciated it when it was put before them, and large numbers of examples of Gallo-Roman *champlevé* have been found.

* The medium used was encaustic, a mixture of wax and resin. The red pigment was oxide of iron; the blue, carbonate of copper; the white, carbonate of calcium (chalk); the dark green, Verona earth.

BYZANTINE.

The subject of Byzantine art has just been taken up by Mr. Aitchison, who has pointed out the enthusiasm with which the buildings were erected, and the luxury and riches, in the form of gold, and silver, and precious stuffs, which were lavished upon them. Procopius says that 40,000 lbs. weight of silver was employed in the sanctuary of St. Sophia, and the Ambo, of rare marbles, was enriched with precious stones and ornaments in enamelled gold; and the dome roof was of gold enriched with gems. If to all the luxury of material we add the Asiatic love of colour, and the employment of Greek workmen and traditions, we shall not be surprised to learn that *cloisonnage* again found a fertile soil. Sculpture being disallowed, *cloisonnage* and mosaic came to the front; and it is here first of all we find an extensive use made of *cloisonné* enamel. The paliotto of St. Sophia is said to have been decorated in this work; and a little piece, stated to have been a part of this, is in Jermyn-street Museum. Though the bulk of all this work has disappeared, a fine example remains—the Pala d'Oro at St. Mark's, Venice, which was ordered originally for Doge Pietro Orseolo, at Constantinople, in 976, though it was subsequently enlarged and altered. There are other works in *cloisonné* enamel, which have been probably brought from St. Sophia with it. Its value is said to be £160,000. It is now in three divisions, one above another. The lower one, with Christ and the Virgin Mary in the centre compartment; on either side the Doge Ordelafo Faliero, and the Empress Irene, and the prophets on the outside of these. In this second division is Christ blessing, with apostles on either side. In the third a figure of an angel, flanked on either side by scenes from the life of Christ. In all there are 83 panels of *cloisonné* enamel in gold. M. de Verneilh says, that when in use, the effect of it is of the greatest beauty, the light reflected from the thin and numerous *cloisons*, &c., eclipsing the mosaics. "With its innumerable figures drawn in lines of fire, and tinted with glowing colours, it is a striking example of the rôle which enamels can play in the decoration of religious monuments."

Cloisonné jewellery for personal use also seems to have been made, the *cloisons* always being very thin, and the enamel very clear and bright. *Champlevé* does not seem to have been used at all.

As in the case of the Egyptians, the use of *cloisonné* in their most precious monumental

works set the taste for other things, and we find the silks and textiles made under Byzantine influence echoing this work. The use of gold, and colour, and lines dividing colours, is often the basis of design.

The MS. illustrations are manifestly inspired by the enamel work, as in the MS. in the Imperial Library at St. Petersburg. The mosaic in the principal nave of St. Galla Placida, Ravenna, is quite a *champlevé* in effect; and the mosaics at Palermo show a general lininess of treatment. The works of Torriti, in the Basilica of St. Jean de Lateran, show a similar use of white dividing lines, and suggested to Mr. Gerspach a Persian faience.

The Byzantine carving is nearly all worked on the edge principle, notably the ivory work. The use made of *cloisonné* by the Byzantines suggests especially panel decoration for the introduction of colour in frontals, pulpits, and the like. Sketches of works executed for St. Mary's, Chester; St. Luke's, Cork; the Harrow Mission Church, Latimer-road, &c., show how this can be done.

RUSSIA (GREEK CHURCH).

The Byzantine traditions seems to have continued down to our own time, in the Greek Church of Russia, though modified by Asiatic and Renaissance influences.

Metal work and enamel hold the principal place in Russian art, though, unfortunately, little remains anterior to the 17th century. But from this date a rich collection exists, and the use of *cloisonné* and enamelled filigree is abundant, and is the principal characteristic of the work. It is, however, used without reserve, and though the effect is rich and gorgeous, it is not very satisfying after the finer works of other times.

It was applied to most varied uses, decorating images or pictures, lockets, crosses, vases, book-covers, lamps, chrisms, and other Church furniture. The imperial crowns, the imperial orb, shoulder plates, and other ornaments of the royal robes, the sceptre and the thrones, are all wholly or in part *cloisonnage*. Damascene work is also prevalent in armour. Shields, scabbards, bow-cases, and armour are also treated with gold and enamel.

The collection of Russian enamels at the British Museum gives an idea of the effect of this work.

MORESQUE.

We must remember also that Saracenic art was largely based on Byzantine art, and here,

FIG. 5.



MONUMENTAL STONE FROM THE CHURCH OF ST. GENEVIEVE, PARIS.

whatever else varies, the use of a gold line to divide colour is constant. The decorations of the Alhambra, for instance, are all based on this, and it is because of this that such infinite complexity and richness have been attained, without losing a sense of chasteness and repose.

MEDIÆVAL.

The history of the Rhenish Byzantine and Mediæval schools of enamelling is comparatively well known, and I will only insist on the fact that until a decadence of taste set in enamel was used in the form of *cloisonné* or *champlevé*.

Byzantine enamel is associated principally with filigree, the Rhenish with chased work, as in the reliquaries of Cologne and Aix la Chapelle. The contrast of the delicately-wrought metal and the rich colour is extremely beautiful. French work is, artistically, much coarser, and more reliance is placed on enamel as an end in itself.

Goldsmiths' work and enamelling appears to have been, about the 12th century, the art most in repute, and was most extensively used for princely presents, for monumental purposes, and for the adornment of all sorts of sacred objects, and its influence must have been great in setting the taste in other arts. I cannot but think that the cultivation of this art gave origin to much that is not generally connected with it. There seems no doubt that painted glass grew out of it. Painted glass appears first in the vicinity of Limoges, about 1100, and the earliest glass known to exist, that of Le Mans, bears internal evidence of its origin. The drapery of the figures is drawn in a way foreign to painted work, but such as would be the natural outcome of cutting spaces out of copperplate for enamelling, and the borders of early windows, and the ornament generally, is just of the character found in *champlevé* enamel. In a few years all trace of this enamel-like drawing disappears.

So again, much early Gothic carved ornament in stone points to an adaptation of the gold filigree work used with enamel, as in the reliquary at Aix-la-Chapelle.

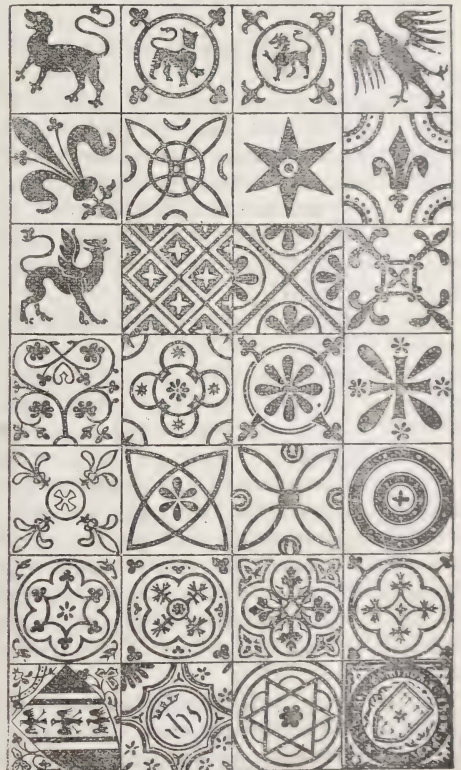
Again, it is evident that memorial brasses are derived from *champlevé* enamelling, as, though they generally are rather in intaglio, many examples exist of parts, as of armorial bearings, &c., with the whole ground cut away and filled in with colour, so as to produce a real *champlevé*.

While the brasses are well known, the stone

slabs which were also largely used are less remembered. They are *champlevé* work in stone, and in some cases metal *cloisonné* is associated with this, as, for example, in the memorial slab of Frédégonde, formerly in the Church of St. Germain-des-Près at Paris, and another of the Bishop Frumauld. The main lines of the design are marked by stone *cloisons* of some width, and subordinate divisions are made in brass, and the colour obtained by a coloured *béton*. Later examples, as that from the church of St. Genevieve, Paris (Fig. 5), and another in the Cathedral of St. Omer, are *champlevés* in stone, filled in with black and coloured mastics. These evidence the appreciation of this kind of inlay by Gothic artists, and offer suggestion for memorials to-day.

For memorials, the use of bronze is evidently of great advantage, as it is unbreakable and imperishable, and being of a different material from the building where it is used, greater liberty of treatment is allowed than would be the case with stone or marble. But it is of itself apt to look heavy and dark, and this defect the use of colour by means of *cloisonnage* removes.

FIG. 6.



PAVEMENT TILES ILLUSTRATING CHAMPLEVÉ WORK.

The colour is added without any loss of preciousness, and this practice can be extended to statuary and relief work.

There is a good deal of pavement work at St. Omer, of marble inlaid with coloured mastic, and this work, it has been supposed, gave rise to the "Norman tile" work, or encaustic tiles in clay, so much used in England, which are, in fact, a *champlevé* in earthenware.

While in the 14th and 15th centuries *cloisonnage* is lost sight of in the Gothic work, the association of gold lines is found extensively in Gothic MS. illustrations.

I have no need to insist further than was done the other evening by Mr. Starkie Gardner, on the art having been practised in England, but it is interesting to accentuate the fact that, here in London, *cloisonné* was being made in Saxon times, and that some of the pieces are at the British Museum to-day.

As to Irish work, not only was *cloisonné* enamel used, but this, with the filigree, seems the basis of the interlacing spiral ornament in the MS. drawings and elsewhere in Celtic work, which has sometimes puzzled archæologists to account for.

RENAISSANCE.

I have, finally, to say a few words of the Renaissance period.

In Renaissance work—founded upon the Roman classic—we find no tendency to a *cloison*-like treatment. Everything tends to relief. And, even in the polychromatic ornament, as at Mantua, &c., relief work is the "*motif*," and colour has to fit in as it can, and, consequently, is rather a "fifth wheel," as the French say.

But, in French Renaissance, we find another type of design; and here the *cloisonnage* system is pervading. This is easily explained. Much of the French Renaissance came through Venice, and Venice was exposed to Oriental influence. Many of the Venetian book covers are scarcely distinguishable from Persian examples. We know how the Venetian bookbinding was brought into France after the Italian wars by Grolier, and, through him, taken up by the Court; and this in itself may have done much to introduce the interlacing patterns so much in vogue in the time of Henry II.

It is because early French Renaissance is pervaded with an Eastern spirit, that the principles of *cloisonnage* are so marked.

In early French Renaissance, book covers, enamelled jewellery, textiles, painted decora-

tion, and especially *appliqué* embroidery, all show this Eastern influence. Enamelled jewellery was abundantly produced, until it commenced to decline, when Louis XIV. sent his plate to be melted up in 1688. A peculiar kind of *cloisonné* was made in France for watch covers. It seems to be a continuation of the Pertubghur method. Several examples are at the British Museum; and designs for this work, by Philip Nolin, are extant.

FIG. 7.



ENAMELS FROM THE RELIQUARY OF LIMBOURG.

We find the same feeling in England under Elizabeth and James I., but, of course, in a coarser and heavier expression. In Germany enamelled filigree was much used.

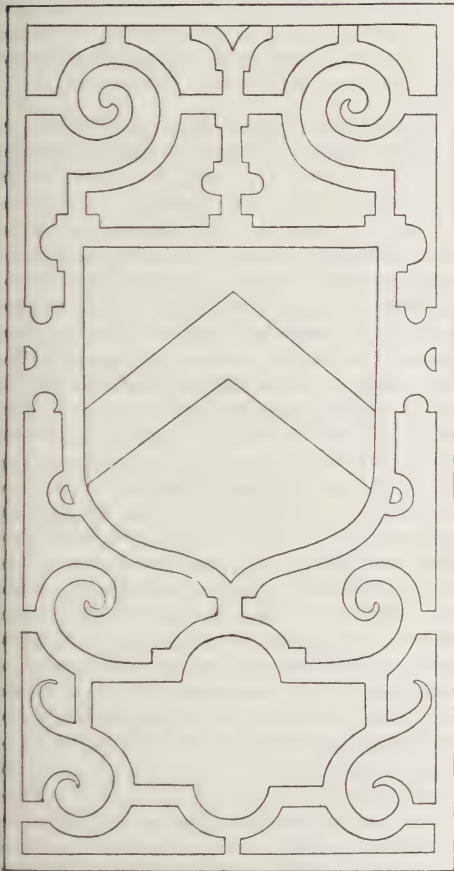
As the impetus of the Renaissance died away, the system of *cloisonnage* completely disappeared; but now that there is such a strong tendency towards early Renaissance, this, as a part of it, should be brought forward again. And it is especially adapted for fire-place decoration.

We have now reviewed the work of long centuries, and the arts of many nations and climes, though the list is far from complete, and we have seen *cloisonnage* pursue its way from the dawn of civilization in Egypt to the present day.

It has always been regarded as something precious, and it has been associated with sacred and royal use, and especially for monumental art. The Pharaohs of Egypt; the warrior kings of Mycenæ; the Sargonidæ of Assyria; Darius and Xerxes; the noble

ladies of Greece; the Byzantine and Hungarian emperors; our English kings, Saxon and Norman; Charlemagne; the line of Russian Czars; Henry II., and Queen Elizabeth are among those who have all, one way or another, used this art; and who shall number the potentates of the great and mysterious East who have glorified themselves therewith? In architecture, the temples of Egypt, the palaces of Assyria, the temples of Solomon, of Ephesus, of Athens, of Olympia, of Pæstum and Metaponte, and numbers besides, have felt its influence; and, in later days, the sanctuaries of Byzantium, Venice, Aix-la-Chapelle, Paris, and Westminster, and numberless others have been enriched by it.

FIG. 8.

ELIZABETHAN ORNAMENT SUGGESTING
CHAMPLEVÉ.

Can it be considered then a barbaric and trivial art? If so, then is all decoration barbaric, for *cloisonné* has flourished at the epochs and among the people whose arts we copy and admire—when decorative design was

at its highest; and it has fallen out of use when beauty of line and beauty of colour were no longer appreciated for their own sake, and artists were forced to lean on some form of imitation or fantastic design.

But we live in a time when walls are not covered with gold or bronze, but with advertisements; when enamel—stored up as a precious substance in Sargon's treasury—is turned out in unlimited quantity, and dedicated to the rival glories of soap and mustard. The ideal of life is cheapness and not preciousness, and bigness rather than beauty; but, above all things, *cloisonné* has ever been valued for its preciousness and its beauty, and its use will therefore be limited to special occasions.

The paper was illustrated by drawings and specimens lent by the Science and Art Department, as well as by drawings and specimens exhibited by Mr. Heaton.

DISCUSSION.

Mr. STARKIE GARDNER said the paper covered so large a field that it was difficult to choose any special portion for comment, but it was to be regretted that Mr. Heaton had not shown more examples of his own work, especially his later productions, for some of the specimens exhibited by no means did him justice. The illustrations on the walls, however, were enough to prove that if this style of decoration were appreciated, there was an immense future before it, especially looking at the admirable drawings of mural monuments, rich in colouring and charming in design, which would form a feature that any church might covet, and they would hold their own even against painted windows, which killed every other form of monument except brasses, which he considered quite out of place on walls. Again for mantelpieces, this kind of decoration would be a welcome change to the everlasting glazed tiles, of which they were beginning to get rather tired. Speaking as a naturalist, he could not help feeling that there was still something to be discovered in the application of *cloisonné*. There were many beautiful shells which had a high natural polish and rich colour, which suggested that a substance might yet be discovered which would be even more brilliant and enduring than encaustic, perhaps some combination of lime with fish glue, which should form a hydraulic cement. If such a composition could be discovered or imitated, they would have a substance with all the beauty and durability of the very hardest kind of marble.

Mr. HUNTER DONALDSON said there could be no doubt that in a climate like that of England, and especially of London, it was exceedingly important to have some decorative matter not easily effected by damp. *Cloisonné* appeared to afford such a

material; but it was obviously very expensive, and could have, therefore, only a limited application. Still, there was a large field for its employment in ecclesiastical and memorial work; and some of the drawings on the walls represented designs by Mr. Heaton for the decoration of conservatories and bath rooms, for which this art seemed specially suitable. It was obvious, that for such work drawings must be first prepared, so that there was a double process to be gone through, involving, therefore, much greater expense than any other kind of decoration. The importance of this point was, that it cast a very great responsibility on the artist who undertook works of such permanence. Where painting or decorating of the usual kind was done, if the result was not satisfactory it could be altered or obliterated; but this could not be done with *cloisonné*; the initial expense was so great, that even if the design were bad or vulgar, the work would probably remain. A great responsibility, therefore, rested on those who practised this art, not to throw off hastily works which they would probably themselves disapprove of in a year or two, but to give the gravest consideration to their designs. Some of the examples shown were of very doubtful merit. The lesson he drew was, that this kind of work should not be done hastily, but that it should be reserved for important works, and everything commonplace and vulgar avoided. The number of drawings which Mr. Heaton had passed round gave some faint idea of the enormous amount of labour he had gone through in studying this subject; and they were all very much indebted to him for having so admirably illustrated this important branch of art.

Mr. SPARKES said it seemed from the paper as if *cloisonné* was only a name for their old friend "outline," which they had all heard a good deal about in the course of their art education. Naturally, when treated in this way, the subject was a very wide one. As to the actual material, which, after all, was the central point of the paper, he thought there was a very great future for it. As had been already mentioned, each material had its own genius, and it would be wholly wrong to attempt to imitate in *cloisonné* brush touches or the outline drawn by a reed pen. The design should be absolutely fitted to the material; but the danger in this, as indeed in all arts, was to withstand the demands of the ignorant public, who knew nothing of art, and were willing to buy the worst and reject the best things put before them. Undoubtedly this material was capable of much more than had yet been done with it. Its durability had yet to be proved, as mastics and cements were as yet too modern for us to speak positively on this point.

Mr. LEWIS F. DAV could not help thinking that the lecturer went rather too far in endeavouring to show that everything was *cloisonné*, more or less. In its origin, however, *cloisonné* was itself derived from jewellery. Jewels were put together with gold to keep them in place; and when jewels could not be

obtained, paste and enamels were used instead. It was a pity that jewels were not used with us in the Eastern manner, as colour, not merely because they were of such money value. He entirely agreed with previous speakers as to the importance of good design in this costly kind of work, but he would go farther, and say the design should be good in every kind of decoration. Short of good ornament, it was better to have no ornament at all.

Mr. C. KRALL showed a specimen of enamel work done a few years ago in France, where a company was started for carrying out this kind of work on a large scale. Mantelpieces, mirror frames, &c., and also circular work, such as the example he had brought with him were made, and these all enamellers knew were very difficult to make. This one was produced by electrotyping the raised lines on a cylinder of copper, and enamel was then laid in between. In old, and in most modern work, the lines were soldered on to the back. Unfortunately, the French company he had referred to did not follow the best models of old work, and he believed it had now ceased to exist.

The CHAIRMAN, in proposing a vote of thanks to Mr. Heaton for his exceedingly interesting paper, and the many valuable illustrations which had accompanied it, said the Society was much to be congratulated on this paper, and the preceding one by Mr. Gardner, dealing with some of the most interesting developments of modern industrial art. It was interesting to see how, from the early days of Egyptian art downwards, wherever there had been a taste for decoration, *cloisonné* in some form had been employed. He had been much struck with the fact shown by Mr. Gardner on a former occasion, that England and Ireland had taken such a prominent place in this art in former days; and it was very gratifying to find that in the Victorian era there was a revival of a method which embodied so much preciousness and beauty. To his mind, the most perfect exponents of this art were the Japanese. The Bowes collection of Japanese art was one of the most wonderful in this country; and there one might see the most beautiful specimens of *cloisonné* enamel, remarkable not only for their beauty of design, but for their richness and harmony of colour. He possessed two very fine vases, something over three feet high, which could only have been produced when the highest artistic talent could be obtained for very low remuneration; for he was told that those vases must have taken two skilled artists three years to produce. He recollected some attempts at a revival of this art in Paris, as also by Mr. Elkington, but the cost seemed to be so great as to prevent any great development of it taking place. He was not prepared to find that *cloisonné* covered such a large field, as he had always connected it with something very precious and beautiful on a small scale; but the enlarged scale on which it was proposed to operate with it was very interesting, and gave great promise for the future

Mr. Heaton seemed to avoid that ordeal by fire which the potter and glass worker had to submit to, and so he escaped certain difficulties; but he might possibly also lose somewhat of permanence. He was delighted to find that potters had been working in *cloisonné* without knowing it, and that they were entitled to some small share in the triumphs which had been recorded.

The vote of thanks having been passed unanimously,

Mr. HEATON, in reply, said he felt very strongly that the specimens exhibited did not do justice to the work, but the paper was rather historical than demonstrative; and the illustrations he had given of what he had been doing were merely suggestive. All he had done was utterly insufficient to show the capabilities of the art, and he did not wish to convey the idea that either the specimens or drawings in any way expressed finality. The whole of these must merely be taken as hints. He felt very deeply what Mr. Donaldson had said about the responsibility of designers, and that was why he did all he could to rake up the records of ancient workers in the hope of gathering instruction. Working in an art like this, one gained experience day by day. The idea of forming an outline first and filling in the colour afterwards was so new when he began the work, that it caused him great difficulty; and it was not until after some months that he got at all accustomed to it; but it grew gradually; and, consequently, the few things he had brought, gathered together haphazard of all dates, showed great variety of merit. As Mr. Sparkes had said, there was a great difficulty with regard to the public, one never knew what what was going to be asked for next. One day something in the early decorative style was wanted; then old Gothic; then something Pompeian; then Japanese; so that every fresh order necessitated a journey to South Kensington, and special archaeological studies to meet the demand. The difficulty of translating these demands into a material like *cloisonné* was very great, especially as cost was always a consideration, and the work was generally wanted immediately. Of course *cloisonné* was outline, but there was this peculiarity, that the outline was an essential part of the design; it formed a neutral kind of separation for fields of colour all on the same level. When we work up a mass of material on one subject, and put it together, we are apt to fancy there is nothing else in the world, but that was not so. It would be perfectly easy to write another paper on art or decoration in which *cloisonné* would have no part at all. As he had endeavoured to show, the great opposing principle was relief work, which was mainly characteristic of Roman art, and there you did not find the *cloisonné* principle introduced at all. Relief work was based more or less on natural foliage, and in all work on that basis, down to the Renaissance, there was an absence of *cloisonné*. On the other hand you found it in all Oriental work,

and work based on Greek models. The art world was, in fact, divided into two great groups, the Roman and the Oriental. There was a certain broad distinction, markedly apparent to anyone accustomed to these subjects, between an outline used as *cloisonné* and one used simply to express the end of something.

Obituary.

EARL GRANVILLE, K.G.—By the death of Lord Granville on Tuesday afternoon, 31st ult., the Society of Arts loses one of its oldest members, and one who for many years was intimately connected with its Executive. Lord Granville was elected a member in 1848, and in the following year he became a Vice-President, an office which he held until 1872. He was again on the Council as Vice-President from 1876 to 1880, and from 1882 to 1885. Besides presiding at the evening meetings on several occasions, he took the chair at several of the Society's annual dinners, chief amongst which was the Centenary Dinner held at the Crystal Palace in 1854, when a very large company assembled to celebrate the hundredth anniversary of the Society. Lord Granville, was the Vice-President of the Royal Commission for the Great Exhibition of 1851, under the Prince Consort as President, and his labours in that capacity did much to ensure the success of that important undertaking, to which, especially in its earlier stages, he devoted much thought and care. He was one of the last survivors of that important company of distinguished men. Of the original Commission the only survivor appears to be Mr. Gladstone. The Commission itself is, of course, still in existence, fresh members having from time to time been appointed. He was also Chairman of the Commission for the Exhibition of 1862. In 1851 Lord Granville was led by the results of the inquiries of a Committee of this Society into the working of the Patent Laws, to move for a Select Committee on the subject, the first step leading to the important reform of the law in 1852. When in 1868, the Society held the important conference on Technical Education, which was the first evidence of public attention being given to this subject, Lord Granville took an active interest in the subject, and delivered a weighty speech at the Conference. In more recent years his arduous public duties left him but little leisure for the Society, but he always manifested himself interested in its welfare, and was on all occasions ready to give that advice which his long experience and his shrewd knowledge of the world so well qualified him to give. On many occasions he has been applied to for counsel and advice, and never was the application made in vain. It is not necessary to chronicle here his important offices in the State or the particulars of his life, which are to be found in the newspapers, but it may be mentioned that he held the office of Chancellor of the University of London for many years.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock :—

APRIL 8.—A. P. LAURIE, "The Durability of Pictures Painted with Oils and Varnishes." W. HOLMAN HUNT will preside.

APRIL 15.—WM. TOPLEY, F.R.S., "The Sources of Petroleum and Natural Gas." PROF. CLEMENT LE NEVE FOSTER, D.Sc., will preside.

APRIL 22.—SIR GUILFORD MOLFSWORTH, K.C.I.E., "Bimetallism." SIR WILLIAM HENRY HOULDSWORTH, Bart., M.P., will preside.

APRIL 29.—WILLIAM ROBINSON, "The Use of Petroleum in Prime Motors."

FOREIGN AND COLONIAL SECTION.

Tuesday afternoon, at Half-past Four o'clock :—

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

APRIL 9.—B. H. BADEN-POWELL, C.I.E., late Bengal C.S. (Punjab), "The Indian Village Community, with special reference to modern investigation." SIR STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., late Lieut-Governor of Bengal, will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

APRIL 14.—G. T. ROBINSON, F.S.A., "Decorative Plaster Work: Stucco Work." WALTER CRANE will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

April 13, 20, 27; May 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 6.—Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. T. B. Lightfoot, "A Trial of a Refrigerating Machine on the Linde System."
Chemical Industry (London Section), Burlington-house, W., 8 p.m. Prof. Vivian B. Lewes, (1) "The Analysis of Illuminating Gases;" (2) "The Products of Checked Combustion."
Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. C. Fortescue Brickdale, "The present Work of the Land Registry."
British Architects, 9, Conduit-street, W., 8 p.m. Medical, 11, Chandos-street, W., 8½ p.m. Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Rev. Theodore Wood, "The apparent Cruelty of Nature."

TUESDAY, APRIL 7.—Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 2 p.m., Annual Conference. 8 p.m., Lantern Slide Exhibition.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. Scott Keltie, "The Geography of Africa." (Lecture I.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m., Mr. R. E. B. Crompton, "The Cost of the Generation and Distribution of Electrical Energy."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archaeology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr.

T. D. A. Cockerell, "The Geographical Distribution of Slugs." 2. Mr. F. E. Beddard, "Notes

upon the Anatomy of *Dilichotis Patagonica*." 3.

Dr. B. Alcock, "A Viviparous Bathybial Fish from the Bay of Bengal." 4. Prof. E. Jeffrey Bell,

"Observations on *Bathybiaster vexillifer*, Wyv.

Thoms."

WEDNESDAY, APRIL 8.—SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. P. Laurie, "The Durability of Pictures Painted with Oils and Varnishes."

Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 2 p.m. Conference continued.

Geological, Burlington-house, W., 8 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, APRIL 9.—SOCIETY OF ARTS, John-street,

Adelphi, W.C., 4½ p.m. (Indian Section.) B. H.

Baden-Powell, "The Indian Village Community,

with special reference to Modern Investigation."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Camera Club, Charing-cross-road, 8½ p.m. Demon-

stration of Flash-light Photography.

Society for the Encouragement of Fine Arts, 9, Con-

duit-street, W., 8 p.m. Mr. T. L. Southgate, "A

Phase of Ancient Egyptian Art." (Musically

Illustrated.)

Royal Institution, Albemarle-street, W., 3 p.m.

Prof. Dewar, "Recent Spectroscopic Investiga-

tions." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W.,

8 p.m. Mr. W. B. Esson, "The Design of Multi-

polar Dynamos."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Archæological Institution, Oxford-mansion, Oxford-

street, W., 4 p.m.

FRIDAY, APRIL 10.—United Service Inst., Whitehall-yard,

S.W., 3 p.m.

Royal Institution, Albemarle-street, W., 8 p.m.

Weekly Meeting, 9 p.m. Sir William Thomson,

"Electrical and Magnetic Screening."

Civil Engineers, 25, Great George-street, S.W., 8

p.m. (Students' Meeting.) 1. Mr. W. F. Pullen,

"Modern Locomotive Construction." 2. Mr. John

H. Barker, "The Design of Locomotive Cylin-

ders."

Astronomical, Burlington-house, W., 8 p.m.

North-East Coast Institution of Engineers and Ship-

builders, Sunderland, 7½ p.m. Mr. W. Hök, "The

Unsinkability of Cargo-carrying Vessels."

Clinical, 20, Hanover-square, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m.

Mr. B. Dawson, "Some Points, chiefly metrical,

in Julius Cæsar."

SATURDAY, APRIL 11.—Botanic, Inner Circle, Regent's-park,

N.W., 3½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m.

Prof. Silvanus Thompson, "The Dynamo." (Lec-

ture I.)

Journal of the Society of Arts.

No. 2,003. Vol. XXXIX.

FRIDAY, APRIL 10, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination will be held by W. ALEXANDER BARRETT, Mus. Doc., at the House of the Society of Arts, and will commence on Monday, the 1st June.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

SIXTEENTH ORDINARY MEETING.

Wednesday, April 8, 1891; W. HOLMAN HUNT in the chair.

The following candidates were proposed for election as members of the Society:—

- Bracewell, William, Brinscall, near Chorley.
- Brown, Prof. Gerard Baldwin, M.A., The University, Edinburgh.
- Davies, David, The Oriental Waterproofing Company, Wallis-road, Hackney-wick, E.
- Friend, Samuel, Cargate, Aldershot, Hants.
- Fryer, Frederic W., Loundoun-house, Surrey-street, Strand, W.C.
- Geen, Charles Alfred, 32, Mount Pleasant-road, Lewisham, S.E.
- George, John Bellamy, 37, Highbury-hill, N.
- Hirst, Hugo, 71, Queen Victoria-street, E.C.
- Knight, Charles A., 114, Newgate-street, E.C.]

- Langton, E. G., 12, Matham-grove, Lordship-lane, S.E.
- Macpherson, George M., M.A., LL.D., Karachi, India.
- Maxwell, James, 29, Princess-street, Manchester.
- Michaelis, Philip, 21, Endsleigh-gardens, N.W.
- Porter, James Neville, 47, Upper Bedford-place, W.C.
- Prentice, Napier, 5, Queen's-road, Erith, Kent.
- Rosenthal, James H., Babcock and Wilcox Company, 114, Newgate-street, E.C.
- Sherrin, George, 33, Finsbury-circus, E.C.
- Southall, Bertram Norman, Beech-house, Redhill, Surrey.
- Tidman, Edward, 34, Victoria-street, Westminster, S.W.
- Weeks, Alfred W. G., 36, Gunter-grove, West Brompton, S.W.
- Wilson, R. P., 2, Prince's-mansions, Victoria-street, S.W.
- Wood, Gilbert, 32, Green-lane, Kettering.

The following candidates were balloted for, and duly elected members of the Society:—

- Green, Joseph F., Heathlands, Gervis-road East, Bournemouth.
- Jackson, Robert Cattley, 7, Loraine-crescent, New-castle-on-Tyne.
- McMullen, J. A., 10, Hanover-square, W.
- Pridmore, Albert E., 2, Broad-street-buildings, E.C.
- Ridge, Samuel Hartshorne, B.A., 257, Victoria-parade, East Melbourne, Victoria.
- Thomas, Carmichael, Palace-gardens Mansions, The Mall, Kensington, W.
- Trevor, Arthur Charles, Karachi, India.

The CHAIRMAN, in introducing the reader of the paper, said he wished to say a few words, in order to show how largely the importance of the question was being recognised. He could corroborate this by reference to the records of the Society, which had done so much for art in different forms, by drawing attention to the means employed for the preservation of paintings and works of art. On 21st of April, 1880, he read a paper in that room, in which he referred to some lectures delivered by a gentleman in the beginning of the century upon the great superiority of copal and amber varnish as a means of preserving paintings. These lectures had great influence at the time, as painters adopted the use of either one or other of these varnishes, and they were much satisfied with the result. Among others were Mr. Linnell, Mr. Creswick, and Mr. Mulready, though some had given up the use of these varnishes, owing to the greater convenience to them of other materials. After 1806 or 1807, the pictures were painted with these materials, and this was the nearest approach to what the old masters used. They had something to look to as the result of the use of a known medium. Independently of that, the system had been most haphazard and unfortunate,

because they had no means of tracing a picture in the event of its turning out to be well preserved. In olden days, a man of 60 or 70, on going into a church or gallery, might say, "I helped to prepare the canvas on which this picture was painted by my master. I know exactly what it was painted with, and therefore I can trace the reason why it has cracked, or been preserved." In the present day painters could not do that, and this fact he had drawn attention to in his paper. In a less distinct way earlier he had seen the need of something of the kind, and in his evidence, given before the Royal Commission in 1863, he recommended that the Royal Academy should be compelled to appoint a chemist, the result being that Professor Barff, and after him Professor Church, was appointed. Until lately, it might have appeared that very little had resulted from the note of alarm sounded here in 1880, but in a quiet manner attention was given to the matter which could not but bring about safety, and now French painters had become alive to the importance of the subject; they were recognising that the materials and systems they were depending upon were, unreliable, that in many cases their use resulted in great disaster; and, as a consequence, they had banded themselves together in order to find a way of curing this great defect. Within the last few weeks he had received a letter from Professor Keim, of Munich, pointing out that in the year 1881 a lecture was delivered by Professor Teclu, the head of the Imperial Museum at Vienna, in which he shewed that the system upon which painters were relying was altogether unsatisfactory, and that something must be done to correct the defective system. It was gratifying to notice that the King of Bavaria, who had taken great interest in the matter, appointed Herr von Pettenkofer as the head of a commission in 1863 to make investigation into the question of the preservation of oil paintings. This gentleman had left a report in which he stated that he was perfectly astonished at the ignorance of artists upon the subject. Professor Keim had recently delivered a lecture in which he reported that great progress was being made. As Mr. Laurie had been working at the matter for some few years he felt sure that whatever he might say would be of the greatest possible importance.

The paper read was—

ON THE DURABILITY OF PICTURES PAINTED WITH OILS AND VARNISHES.

BY A. P. LAURIE.

When we look at the Van Eyck, No. 186 in the National Gallery, we are at once struck with its wonderful state of preservation. The reds, probably produced by glazings of lac, or Brazil wood, or kermes lake, over a yellow or red ground, seem certainly to have slightly

faded, and turned brown, when compared with fresh preparations of the same lakes made from the old receipts; but they are in very fair condition, and the green on the wife's dress is marvellously brilliant. This green is worthy of special attention, as it seems to be agreed among the authorities on these matters, that it can only have been produced by a glazing of verdigris, a pigment which we now know to be of a most dangerous character, turning black, and corroding and destroying other colours. The oranges in the corner are apparently painted with orpiment, another dangerous colour to use.

With reference to the reds, I have already mentioned the three lakes, which are most commonly referred to in old receipts, madder being hardly ever mentioned. Of these, Brazil wood is very fugitive, turning a dirty brownish red, and fading very much if only exposed to sunshine for a few days. Lac lake, though better than the last, is not a permanent lake, and of kermes very little is known beyond the fact that it yields a permanent dye. Unfortunately these lakes, when prepared from the old receipts, are so much alike, that it is impossible to identify them on a picture. Judging, however, by these receipts, one lake is as likely to have been used as another.

In this picture, then, painted early in the 15th century, we probably have verdigris, a notoriously fugitive pigment; orpiment, a pigment very apt to change; and a lake which, assuming that kermes is a permanent colour, may or may not be permanent, according to which of the three lakes above mentioned has been used.

It cannot, then, be held that the preservation of the picture is due to the pigments used, and we must, therefore, look elsewhere for an explanation of its freshness.

If, then, the secret does not lie in the pigments, it must lie in the vehicle; and this leads us to consider what properties a vehicle must have, to produce so remarkable an effect.

This question is very easily answered.

It has been again demonstrated by Prof. Russell and Captain Abney, in their report on water-colours (1888), that most fugitive pigments are permanent, if protected from moisture, and a still larger number, if protected both from air and moisture. If, then, we can obtain a vehicle which will really protect the particles of the pigment from moisture, we may use with safety many pigments that are now regarded as fugitive.

At this point one is apt to think that the

inquiry is concluded, as we are accustomed to assume that ordinary varnishes and oils do preserve surfaces from the action of moisture; but, unfortunately, if a sufficiently delicate test is applied, this is not found to be so. The method I have devised for doing this is to use as a pigment ignited sulphate of copper, which is, of course, a very hygroscopic body. If we grind a little of the ignited sulphate with linseed oil, and paint it out on a glass slide, we get an enamel-like white surface, with sometimes a slight greenish tinge in it.

If this is placed in a desiccator to dry, it remains the same in appearance; if, however, when dry, it is exposed to the air of a room, it gradually turns green and transparent; or if it is exposed under a bell-jar beside a dish of water, the change takes place much more rapidly, twelve hours being often sufficient. If we now examine the slide under a microscope, we usually find that no definite crystalline formation is visible, but occasionally here and there are to be found complete crystals of sulphate of copper, due, apparently, to a slow aggregation of molecules in the colloid linseed oil.

I shall begin by describing the experiments I have made on linseed oil alone.

LINSEED OIL.

The linseed oil of modern commerce differs in several important particulars from that used by the old masters. Hot-pressed from adulterated seed, refined by the addition of sulphuric acid, and then probably further adulterated with other oils before it is put on the market, it is a very inferior product. The oil of the old masters seems to have been cold-pressed from pure seed, and then refined by exposure to sunlight, and washing with water.

In converting it into boiled oil, various methods and substances were used, such as exposure merely to the sun till it thickened; boiling it with bone ashes and pumice; boiling it with ignited sulphate of zinc; boiling it with litharge or with white lead, or with umber; or exposing it to the sun exposed in leaden dishes, or mixed with white lead.

The modern practice is probably, in many cases, similar, salts of manganese having been added to the list, and such substances as sulphate of zinc having been abandoned.

My impression from the study of the old receipts is that, probably, in most cases litharge or white lead was used, just as it is most commonly used now. We have, then, to look rather to the earlier stages of the pre-

paration of the oil, to find any serious difference between ancient and modern practices.

With a view to finding whether the capacity of linseed oil for resisting moisture would be improved by following any of the old methods, I tried the following experiments. I obtained—

1. A sample of ordinary pale drying oil of the best quality.

2. A bottle of drying oil from one of the leading firms of artists' colourmen.

3. A sample of Bell's medium from Messrs. Bell and Co., of Oxford-street. This medium is prepared by cold-pressing carefully sifted seed, and then keeping the raw oil at a temperature of about 100° C. for some weeks, until it becomes thick and viscous. This "fat oil" is then thinned with oil of spike for use.

4. I obtained some raw oil, cold pressed, from sifted English seed, which I then refined in the following manner. A bottle was filled one-third full with salt water and sand, and one-third full of oil, and was placed out in the sun, with a loose cap over the top for four weeks. By the end of that time no more precipitate was formed, and the oil was drawn off, filtered, and converted into boiled oil by heating to 120° C. for 120 hours with borate of manganese.

5. Another portion, after refining, was converted into oil, by heating strongly for three hours with bone ashes, adding ignited sulphate of zinc, and allowing it to settle and stand in the sun, according to an old German receipt, which is quoted by Eastlake in his "History of Oil Painting." Slides were painted out with these different oils, mixed with sulphate of copper, and, after having been dried in a desiccator, were exposed to moisture. They all turned green at approximately the same rate, and repeated experiments did not show that one had much advantage over another. If a slide is varnished with oil, after being dry, it, of course, resists a little longer; but four layers of such varnishing only protect the slide for three days instead of one.

As far, then, as these experiments are concerned, there seems to be no reason to suppose that the pure oil, sun-refined, has much advantage over the commercial oil, or the different methods of converting it into boiled oil exercise an appreciable effect. Only one point seemed to remain unsettled. It seemed possible that the old oil, imperfectly pressed, might be superior to that obtained by the hydraulic press. In order to test this, I had

some fresh seed pressed, and took samples during the pressing, dividing the oil into three parts. Taking the first part of these, I refined it, boiled it with borate of magnesia, and tested it. The moisture penetrated through it as before.

These experiments seem to show, then, pretty conclusively, that linseed oil, no matter how pure or how carefully refined, or in what way it is converted into boiled oil, cannot be depended upon to protect a surface from moisture. In the course of these experiments, I was struck with the fact that linseed oil which had been kept for some time after it was dry in the desiccator seemed to resist better than lately-dried oil, when exposed to moisture. Three weeks was found to make a considerable improvement, and two months still further improvement. These experiments are being continued, with a view to finding at what point the improvement will cease.

When we consider the nature and constitution of linseed oil, I do not think we need be surprised at its permeability to moisture. Besides containing linoleine, it also contains considerable quantities of non-drying fatty acids, which, being unaltered during the oxidation of the linoleine, must tend to produce a spongy and porous surface. According to Allen, the dried film contains free glycerine, which must not only tend to increase its porosity, but also to act as a carrier of moisture. Taking these different facts into consideration, the passage of moisture through linseed oil is not surprising.

I should like to refer here to a theory which has been recently advanced, that lead dryers are injurious to pictures on account of the formation of lead soaps. As far as these experiments are concerned, we have no confirmation of this; and I confess that the theory seems to me a very startling one in the light of the fact that the white lead used by the old masters was prepared by the Dutch process, and therefore contained large quantities of lead hydrate, and of the fact that the oldest receipt I am familiar with for preparing drying oil, devises that this should be done by boiling with oxide of lead.

When Mr. Scott Taylor tells us that the Venetian painters were accustomed to grind their white lead repeatedly in vinegar, I can only suppose that chemists, like poets, are sometimes caught nodding. It seems to me more probable that treatment with lead salts may remove some of the fatty acids other than linoleic acid as lead soaps. I do not find,

however, that the oil which rises to the surface of ground white lead protects from moisture any better than ordinary oil.

WALNUT OIL.

Walnut oil is frequently referred to in the old receipts, and seems to have been largely used by the old masters for painting. It can be prepared by pressing the kernels of walnuts after slightly warming them. The walnuts should be about three months old. The oil obtained is very pale, and dissolves white lead freely on boiling, becoming darker in colour. I prepared a little by boiling the kernels of the walnuts with water, after pounding them in a mortar, roughly separating the oil which rose to the top, dissolving the oil in ether, filtering, and evaporating off the ether. I then converted this oil into a boiled oil by heating it with white lead. On testing it with the sulphate of copper, I found that moisture rapidly penetrated, showing that it is no better in this respect than linseed oil. As these were the two oils which were used by the old masters, the protection of their pigments cannot have depended upon the moisture of the oils used.

RESINS.

In order to test how far pure resins will protect the sulphate of copper from moisture, I dissolved them either in spirits of turpentine or in benzole, ground the sulphate of copper with the solution, and painted it out on a glass slide. I have not attempted an exhaustive examination of resins, but have contented myself with a few typical ones, namely, colophony, mastic, Sierra Leone copal, and amber. The varnishes were all prepared by first fusing the resin, and then gradually adding the spirits of turpentine to the fused mass.

The change of appearance on exposing one of the slides thus prepared to moisture, was quite different to the appearance in the case of oil. The surface became an opaque greenish-blue in the course of a few hours in the case of colophony, mastic, and Sierra Leone copal, but after that there was no further change. On then examining these slides under the microscope, this appearance was explained. The whole surface was rough and covered with blue cones of sulphate of copper with unaltered white plains between. Apparently the varnish on drying became full of small cracks or holes, through which moisture penetrated, but in itself resisted the passage of moisture. These holes were so close together as to give the whole surface a blue appearance when ex-

amined with the naked eye. The one exception to this was the amber varnish. It resisted the attacks of moisture for weeks without change. I think, however, that we may consider that such solutions of resins protect a surface from moisture sufficiently well for all practical purposes. The slight change taking place in the sulphate of copper does not go any further, and would, I think, be imperceptible in the case of a fugitive pigment.

I need hardly point out, however, that such solutions are quite unfit to be used as mediums in place of oil, and that the surface formed is brittle and not very durable.

OLEORESINOUS VEHICLES.

Eastlake, in his "History of Oil Painting," devotes himself principally to trying to determine what medium was used by Van Eyck and his immediate followers. As his book is the most important work on this subject, and he has devoted immense pains to investigating all the documentary evidence, the theory he advances requires specially careful examination.

Briefly, his theory is this: that the Flemish painters ground their colours in oil; that they prepared a varnish, by dissolving a resin, preferably amber, in oil, and that they mixed a little of this with the colour. He claims that such a medium protects the pigment from moisture, and that it is only necessary, in the case of specially fugitive pigments, such as yellow lake, verdigris, &c., to increase the proportion of varnish and diminish the proportion of oil, in order to effectually lock them up, and protect them from the action of a moist climate. This he calls the oleoresinous vehicle; and, while undoubtedly showing that this, in all probability, represents their usual practice for ordinary pigments, I think he fails to make out that they relied upon this method in the case of notoriously fugitive pigments. In fact, curiously enough, as I shall presently show, any evidence he brings forward, points in quite a different direction. At the same time, he quotes from a sufficient number of authorities to show that he correctly describes their general practice: a practice for which there are sufficient reasons, apart from the question of the preservation of specially fugitive pigments.

It has been shown by Professor Church that even so hard a resin as copal, when dissolved in a volatile medium, after a year becomes covered with minute cracks; that this is also true of copal dissolved in the usual quantity of

oil necessary to make a varnish. But he finds that if a copal oil varnish is mixed with a certain proportion of oil, it forms a surface which is hard, and, therefore, preferable to oil alone, which is soft, but which does not crack. There seems to be no doubt, therefore, that apart from other considerations, the mixture of a resin dissolved in oil with oil produces the most permanent surface. It remains to be seen whether such a medium has the quality claimed for it by Eastlake of protecting the pigments from moisture.

In order to experiment upon this matter, I obtained (1) a very fine sample of a genuine copal varnish from Messrs. Freeman; (2) Mander Bros., Coburg varnish; (3) I dissolved Sierra Leone copal in my own pure linseed oil, and heated it till it became stringy, as directed in the old receipts; (4) I dissolved amber in the same way in the pure oil; (5) I boiled some of the amber varnish mixed with white lead till almost solid, and then diluted it with spirits of turpentine. I then prepared slides with these varnishes mixed with the sulphate of copper; comparing the slides painted with pure oil with slides painted with a mixture of oil and varnish, and slides painted with the varnish alone.

In some cases, the slides after drying were varnished with the mixture that had been used in painting them out. In making the varnishes. I mixed about one-third resin with about two-thirds oil.

None of these preparations resisted the attacks of moisture. Those containing varnish resisted a little longer than those merely containing oil, but the difference was probably due to the greater thickness of the protecting layer.

As far, then, as we can judge, by the sulphate of copper test, Eastlake's theory that an oleoresinous vehicle will protect a fugitive pigment is not correct. It seemed to me necessary, however, to check these results by some experiments made in another way, and I therefore determined to try whether such mediums would protect a fugitive pigment.

In order to reproduce, as near as possible, the conditions necessary in the case of one of the old masters, I prepared some Brazil-wood lake, according to one of the old receipts, and after careful washing and drying, ground it with the following mediums:—

1. Commercial pale boiled oil.
2. Rowney's boiled oil.
3. My pure oil.
4. The pure oil mixed with amber varnish.

5. The pure oil mixed with copal varnish.

All of these faded when exposed to sunlight, and apparently faded at the same rate.

To confirm this result, I next rubbed out on two glass plates carmine ground in pure oil. After the two plates were dry, I put one away in the dark, and exposed the other to light. At the same time I rubbed out on two other plates, carmine ground with pure oil and a little amber varnish, and exposed one of these to light. The two plates kept in the dark retained their brilliancy, while the two exposed to light quickly turned brown at the same rate.

I think that these experiments show pretty conclusively that whatever method may have been used to preserve fugitive pigments by the old masters, it cannot have been that of grinding colours with oil, and then mixing in a little oil-varnish, as supposed by Eastlake.

In order, then, to solve this problem as to the nature of the vehicle used to preserve fugitive colours, it is necessary to lay aside the theories of such writers as Eastlake, and examine carefully such old receipts as are available. This is all the more necessary, as the word varnish is used so carelessly by writers on this subject, for they seem to think that all varnishes have similar properties, and therefore it does not matter whether the nature of the varnish is stated or not.

The result of a more careful and minute inquiry has been the discovery of an old medium of remarkable properties. It is too early, however, to say anything in public as to this medium, until it has been thoroughly tested. I, therefore, shall say nothing of it here, but reserve to some future date the complete statement of its preparation and properties.

Leaving this question, I will next describe the experiments we have made on the effect of a layer of varnish of different kinds over linseed oil.

Sulphate of copper was ground with linseed oil, painted out on glass slides, and allowed to dry in a desiccator. They were then varnished respectively with copal dissolved in oil, copal dissolved in turps, amber dissolved in turps, and mastic dissolved in turps. The first to give way and show the passage of moisture were the slides varnished with copal in turps and amber in turps; while the slide which resisted moisture longest was the one coated with mastic and turps.

I find that a good mastic varnish will protect for some weeks a slide which would otherwise turn green in a few hours.

The reason for the superior behaviour of

mastic is, I think, not far to seek. It forms a soft elastic coating over the elastic oil, which is more durable and less likely to crack than the hard brittle coating formed by the amber or the copal. Experiments upon other resins have confirmed this view. These experiments then add another argument in favour of the use of mastic varnish for pictures to those already known.

To repeat these arguments briefly:—The use of an oil varnish for a picture has this objection, that it will turn yellow with age, or even, if it contains lead dryers, as in most cases it does, dark brown with age, thus increasing the defects of an oil picture, and cannot be removed without great risk of destroying the coatings of colour underneath; while, as has been shown by these experiments, it affords little or no protection to the picture from the action of moisture.

The use of copal or amber, dissolved in spirit, is also objectionable, because the varnish is difficult to remove. By using mastic, we have a varnish which, while affording the best protection to the picture from moisture, is easily removed and renewed, without any danger of injury to the picture underneath. This seems of special importance in a country like this, where pictures are exposed to the greasy, sticky dirt produced by coal smoke. As might be expected, from its capacity of keeping out moisture, mastic varnish also affords a good protection to white lead from the blackening action of sulphur gases.

It must not be supposed, however, that in selecting the best varnish for a picture, we have solved the problem before us. Not only can moisture readily penetrate through the back, but supposing the back to be protected, it is only a question of time for the moisture to penetrate through the front, as having once succeeded in passing through cracks in the varnish, it is able to move about freely through the oil underneath.

There is another danger in the use of an ordinary oil medium. There is no doubt that if certain pigments ground in oil are mixed together, they will act chemically upon each other. Such, for instance, as cadmium yellow and emerald green, which, if mixed together, rapidly turn black. At first sight this is difficult to understand, as it seems unlikely that dry particles of colour, each isolated by a layer of oil, could act upon each other. When we remember, however, the complicated nature of linseed oil itself, and the complicated changes that take place while it is drying,

resulting in the presence of free fatty acids, of glycerine, and of moisture, it seems quite possible that certain pigments could be dissolved and decomposed, and once in solution they would probably diffuse through the oil, even though the oil was dry, just as we know that salts will diffuse through solid gelatine.

Mr. Holman Hunt has got in his studio a remarkable example of such diffusion. A patch of emerald green placed on the canvas, ran down until it came in contact with a patch of cadmium yellow; the blackening caused by this is not confined to the point of contact, but has gradually spread.

With a view to testing this point more carefully, I rubbed out on a glass slide two patches of cadmium yellow. When they were dry, I rubbed over one of them some emerald green, and over the other some boiled oil. When the boiled oil was dry, I rubbed over that some emerald green, so that in the one case we had the emerald green isolated from the cadmium yellow by the thin layer of oil which rose to the top of the cadmium yellow in drying, and in the second case by the thick layer of oil which was purposely placed between them. After keeping for some time, both of these patches began to grow dark, the one with the thin layer of oil changing markedly, while the one with the thick layer of oil changed slightly. These films were then stripped off, cut in sections, and examined under the microscope. This can be very readily done by embedding such a film in paraffin wax, and cutting and mounting in the way used in the Biological Laboratories at Cambridge.

Though little could be seen in the case of the film with the thick layer of oil, it was quite easy to see, in the film with the thin layer of oil between the two colours, that the emerald green was unaltered, but that the top of the cadmium yellow was covered with a line of black spots, showing that the emerald green must have dissolved and diffused through the oil to attack the cadmium yellow.

These experiments, I think, show that we have not only in oil paintings to guard against external dangers.

We have, then, two policies before us. One is to obtain a medium which will effectually lock up pigments from external danger and from internal solutions and diffusions; and the other is, recognising the imperfection of the medium we are using, to select pigments which are unaffected by the medium, and least likely to injury from external sources, such as moisture, and so on.

Apparently, the most durable surface that can be produced with modern mediums is that obtained with a mixture of copal oil varnish and linseed oil.

Until, then, the proper medium is discovered, the best we can do is to paint our pictures with this medium and a carefully selected group of pigments, and then, as a further precaution, coat the pictures, when thoroughly dry, with a layer of mastic dissolved in turps.

DISCUSSION.

The CHAIRMAN thought the observations which they had just listened to would be of the greatest possible value in teaching them what to avoid, though, for practical purposes, the inquiry had a somewhat negative result. Speaking of copal and amber, he might say that certain pictures painted by men who took the advice of Linnell and others had been remarkably well preserved, but in the case of one picture at South Kensington, which had been so treated, Mulready found certain inexplicable white spots upon it. At first it was impossible to account for these spots, and Mulready asked the authorities to let him take the picture to his studio to investigate it, and, if possible, to cure the defect. Upon examining the picture with a strong microscope, he found that each little spot was a round ring, and in the centre there was a little circumference of the colour which it had actually been before, but that outside there was the bare canvas. On examining it more carefully, Mulready discovered that these spots had been caused by the saliva of the people standing in front of the picture, the saliva as it dried having contracted the colour. This was a proof that amber varnish was not sufficient to protect a picture. The picture was restored by Mulready, and a similar mishap had been avoided by placing glass in front of it. Many of the pictures painted with amber and copal had stood in a way which could not be expected from oil alone; they were not more substantial, but the colour had been better preserved. One could not be certain about pictures painted by other people, but he might refer to one painted by himself in 1850, entitled "*The Rescue of Christian Priests from the Persecution of the Druids.*" One priest had a robe of great brilliancy, with a white linen dress underneath, and another had a red coat with a white garment beneath, the vegetation being painted from nature out of doors in the sunlight, and this picture, which was now in the possession of Mrs. Coombe, at Oxford, had stood remarkably well. The way in which that was done was as follows: each morning he put into a cup a portion of copal varnish, and an equal quantity of linseed oil, combining the two with a little rectified spirit of turpentine, and used it for his day's work. No doubt, microscopically, many defects might be found in the picture, but to the eye

none were apparent. Pictures painted by Millais at the same time were painted at once on a white ground, as his were, and with copal or amber, and the picture from Keats at Liverpool was a marvel in its condition as to colour and purity. With regard to the superiority of mastic for preserving paint, he thought it necessary to utter a word of caution, as many picture dealers were in the habit of giving a picture, if it was dull, a coat of varnish without any regard to how the picture was painted. If the picture was painted in one coat, as in the case of the Van Eyck, there was very little oil in the earths, and colours made from the juice of vegetables to protect them, and therefore, before having a coat of mastic, it was desirable that it should have a further coat of a mixture of resin varnish and oil.

Mr. WALTER F. REID said that he had made many experiments in the laboratory on this subject, but he had found it necessary at the commencement to take one line only; and the line which he took related chiefly to the vehicles, and not to the pigments. As to the remark about the Van Eyck, that the green had been produced by verdigris, he thought it was possible that it might be malachite, as he had lately come across an old recipe for grinding up and mixing the verdigris with powdered marble; the result of this mixture would practically be malachite. As to moisture, he thought the question arose whether the water might not be produced in the decomposition of the organic substance of the medium itself. It was highly probable that during the oxidation of the linseed oil water was formed, but this was a subject which might possibly form a subject for future experiment. In boiling linseed oil many peculiar substances had been mentioned which had to be added during the boiling, but the majority of these had no action whatever upon it. The oil was usually boiled with litharge and red lead, though he preferred a mixture of both, as this gave a perfect oil for all practical purposes. In refining the oil, if it was treated by mixing it with water, and exposing it to the air, in the sun, part of it was oxidised, the unoxidised oil, being heavier than water, would settle at the bottom, which was an important matter. Some of the old masters put the per-centage of oil which was lost in the refining at from 50 to 70 per cent. The residue was not diluted with a fatty oil or drying oil, but with a volatile substance, such as oil of spike or oil of lavender. Having spent many hours in trying to solve the problem as to what were the distilled oils formerly used, he had come to the conclusion that in nearly every recipe for distilling oils mentioned by the old Italian and German writers, some substance was used which gave a volatile distillate; in some cases they either mixed mastic varnish, or mastic itself, and in one case the painter recommended the mixing of linseed oil with sufficient lavender flowers to absorb it, and then to distil the mixture

with water. It was probable, therefore, that some distilled oil which was used was not any product from the distillation of linseed oil itself, but from substances mixed with the oil in distilling. He did not agree with Mr. Laurie that a spirit varnish could be easily removed without injury to the picture, his own opinion being that it was very difficult to remove it without acting on the medium of the picture. As to the solubility of the colours in the medium, and the interaction of the colours, he thought this might be accounted for by the formation of certain salts which acted upon each other. Old writers dwell on the importance of not using too much oil, and he thought in this respect they were correct. The difficulty with linseed oil was that up to the present its subsequent history was not known. Pettenkofer stated that dried oil was insoluble in water, spirits of wine, ether, oil of turpentine, and other liquids, and this was correct when the oil was fresh, but after a time a change took place in it upon being exposed to the air, and this change was of great importance to artists. After four or five years, the surface of a piece of pure oxidised oil, either boiled or raw, became sticky, and after a lapse of ten years the whole of it was converted into a sticky substance which changed its qualities. In the first instance, oxidised linseed oil was insoluble in different substances, especially alcohol. If linseed oil at that age was treated with alcohol it would be dissolved entirely. A new picture might be immersed in alcohol without its being injured, but an old picture would be destroyed. On the table were two specimens of oxidised oil, one being boiled linseed oil oxidised in 1878, the surface of which, after four or five years, began to get sticky and to run down, the other sample being raw linseed oil of the same age which was perfectly oxidised. The first specimen had been boiled in the ordinary way with one-half per cent. of litharge and a half per cent. of red lead. In the first oxidation of linseed oil there was a great increase in weight and bulk, the increase in weight being about 11 per cent., though he had not been able to tell the exact increase on the second oxidation. The consequence was there must be wrinkles on the oil, if the film was thick, owing to this increase in weight. The properties of the modified oxidised oil were of the greatest importance for the subsequent treatment of pictures; and Pettenkofer was not aware of this, as he distinctly stated that the oxidised oil was insoluble in alcohol, which was not correct. One might, perhaps, wonder why pictures were not sticky after a length of time, but the reason was, first, that the basis on which they were painted was porous, so that the liquid was absorbed by it, and the pigments themselves absorbed a great part of the semi-liquid products as they were produced; and, in the next place, they would combine with them, especially lead. This brought him to the consideration of the quantity of oil which artists used for different pigments: 100 parts by weight of white lead required 12

parts by weight of boiled linseed oil, 100 parts of zinc white required 14 parts of boiled linseed oil, 100 parts of chrome yellow required 19 parts of linseed oil, 100 parts of ivory black required 112 parts of oil, 100 parts of burnt sienna required 181 parts of oil, and 100 parts of raw sienna required 240 parts of oil. Dark colours required more oil, as they were not of a basic nature and did not combine with acids; consequently the oil, doubly oxidised, remained in its semi-liquid, or liquid, state unless the canvas absorbed it. As the results of experiments made with gums, he found that melted gums were not so fine as gums in their natural state. If you took a piece of copal and melted it, it would be found to be beautifully bright, but after a time it became covered with cracks, though the reasons for this have not been ascertained.

Professor ROBERTS - AUSTEN, C.B., F.R.S., thought the author of the paper had made an extremely happy selection of a material to test the presence of moisture in anhydrous sulphate of copper. It was quite true they did not know much about thin films, though they knew more about thicker films. One might suppose that stretching a thin transparent sheet of india-rubber over a picture would protect it, but such was not the case, as carbonic anhydride and sulphurous acid would find their way through its surface. These gases, which were always present in a place like London, might lead to the permeation of water through the film. With regard to diffusion, it might not always be a question of diffusion of a crystalline pigment in a colloidal salt, for solids could diffuse through solids; e.g., if one floated a piece of pitch on water, and placed a cork beneath, the cork would find its way up through the pitch. The Japanese had been most successful in preserving the colours they employed beneath their lac; and he suggested that the nature of the lac used by them was well deserving of further examination. With regard to the formation of malachite, which had been referred to in the Van Eyck, he thought that the suggestion was quite probable.

Mr. JOHN HUGHES said he should be glad to have Mr. Laurie's opinion of a medium composed of equal parts of linseed oil, turpentine, and water. This medium formed a milky-like fluid, and was very nice to paint with.

The CHAIRMAN said in his younger days he recollected a medium which was composed of linseed oil, water, and sugar of lead, to combine with which there might have been turpentine, but about this he was not quite certain. With regard to the green in the Van Eyck, he thought verdigris alone could not have been used, and that there must have been an admixture—an opaque pigment, possibly—of malachite to give solidity. If verdigris alone had been used over the yellow ground, there would not have been a solid colour, it would have been filmy and starchy.

Mr. LAURIE, in reply, said he thought the rate of

change depended entirely on the external moisture, it being more rapid according to the way the experiment was performed. If done in an ordinary room it would be very slow, but if under a bell jar, with a saucer of water, it would go on very rapidly. With regard to refining oils, so far as his experience went, the bulk of the water was not very much affected; a considerable amount of white flocculent precipitate separated out, though it was a small proportion to the bulk of the oil. The oil got faint in colour and the precipitation seemed to stop. He had not noticed the removal of a large quantity of oxidised oil, his aim being simply to get the oil to a pale colour and to remove from it the gross impurities. In the case of the films he examined microscopically his first idea was that solid particles were falling through the oil, but on examination he found no trace of this, so he came to the conclusion that it was more likely the colour had been partially dissolved, and was diffusing as separate molecules than as actual particles. With reference to the verdigris in the Van Eyck, he was not able to say that it had not been mixed with other things. After what had been said, he thought the best thing artists could do would be to avoid the use of linseed oil altogether. In order to arrive at a definite conclusion upon the subject, it was necessary that three people should work together, viz., the manufacturer of colour, the artist, and the man of science. He was unable to answer the question put by Mr. Hughes, as he had no knowledge one way or the other of the medium named, though he could not not imagine that any advantage would be gained by the admixture of the water.

The CHAIRMAN, in proposing a vote of thanks to Mr. Laurie, said every one knew that the old English pictures which were painted with oil had stood—for light and shade, if not for colour—very well indeed; but still this was no reason why they should not try to find something better. Until a perfect medium was discovered, he thought artists might still go on painting with oil, or copal and oil.

The motion having been unanimously passed, the meeting adjourned.

Miscellaneous.

THE WOOD AND IRON INDUSTRIES OF SWEDEN.

The United States Minister in Stockholm, in his last report, says that next after agriculture the two great products of Sweden are wood and iron, and these are her two chief exports as well. Timber was exported from Sweden during the reign of Gustavus Vasa, at least as early as 1546, and in 1659 the Swedish Chancellor Oxenstiern called the Swedish forests "the most precious gems of the realm." The vast Swedish Norrland, and the great central district of the country also, is still covered for the most part

with a great black forest, consisting largely of pine and spruce. The general trend of the Scandinavian peninsula, as it stretches away towards the pole, is north-north-east. The lofty *fjeld* plateau which lies along the boundary between Sweden and Norway, and which is called the *Kölen* (the keel)—the maritime Scandinavians likening their country to a boat turned bottom upwards—has the same direction. From this high *fjeld* rise numerous rivers which, flowing in a south-easterly course—at last fall into the Gulf of Bothnia. Among these rivers are the Tornea, Kalix, Lulea, Piteå, Skelleftea, Umea, Angerman, Indals, Ljusne, Ljungan, and Dal-Elf. They all lie to the north of Stockholm, nearly all in Norrland. Upon this enormous watershed stand the chief timber forests. Along all these rivers and many smaller ones and their tributaries, are carried on extensive lumbering operations. Towards the end of the year the Swedish lumbermen go into the woods and fell the trees. They haul the logs to the banks of the river or brook all through the winter, and in the spring they float the logs down the streams to the mills near the gulf. At the mouth of most rivers is a town which usually takes its name, as it does its business and prosperity, from the river. Here are large saw-mills, with both steam and water power—some of them built of stone, brick, and iron—and here the logs are sawn principally into battens, deals, and boards, which are piled up into vast squares, that almost conceal the town as it is approached from the direction of the sea. South of Stockholm, lumber operations are conducted on both the east and west coast, and there is a considerable export from Gothenburg, most of the timber coming from the grand Khar-Elf, which flows into Lake Venern. The great bulk of the timber, however, is cut and sawn in Norrland, and 85 per cent. of the lumber exports come from the north of Stockholm. It is only within the present century, and, in fact, within the last thirty years, that the Swedish timber trade has assumed anything like its present importance. The production of wood pulp has increased very rapidly in Sweden of late years. It is made chiefly from spruce, and that manufactured by the sulphate process is highly esteemed, and meets with a ready sale. The greater part of the wood pulp is consumed in the country; but in 1885, 16,000 tons were exported, and in 1889 the export had increased to more than 52,000 tons. The greater part goes to England, Denmark, and the United States. More than one quarter of the entire wooded area of Sweden, or 14,300,000 acres, belong to the Crown. This is valued at about £2,830,000. These forests are supervised with great care, and all Sweden is divided into forest districts, and these, in turn, into *revir*. Each district is under the supervision of a chief forest inspector, and each *revir* is guarded by a forest ranger and a number of under-keepers. It is the opinion of the United States Minister that the vast forests of Sweden will be preserved and maintained substantially as they stand to-day; and

that Sweden's lumber export—her greatest source of income—will be maintained and kept good for ages to come. As regards the second important article of export, namely, iron. This is celebrated throughout the world. It is soft, ductile, and possesses great pliability and strength. For centuries, Swedish iron has furnished the world with the raw material for the best tools and weapons, the finest springs and drawn wire, and the best description of nails for rivetting and clinching. The excellence of Swedish iron depends partly on the fineness of the ore, most of it being free from both phosphorus and sulphur, and partly upon the superior manner of smelting. All Swedish iron is smelted with charcoal, which is comparatively cheap, as the forests grow upon the iron beds. The supply of ore is practically inexhaustible. It is found all over the country; and not only occurs in the thick strata in the rock, but forms a large part of the bulk of great mountains in various portions of the kingdom. The largest of these iron mountains is Gellivare, situated in the Swedish-Lapland, beyond the Arctic Circle. The ore occurs here chiefly in four gigantic strata, and covers so large an area, that it is estimated that if only one meter (3.28 feet) in depth is taken out a year, the yield would be 943,600 tons, nearly equal to the amount now produced by all the mines in Sweden. This Gellivare ore is also very rich, containing no less than 70 per cent. of iron. Much of it, however, contains apatite, and in such large quantities, that the question of turning to account the phosphoric acid held in this mineral is entertained. A railroad has recently been built, and is being put into working order, from Lulea, near the head of the Gulf of Bothnia, to the iron deposits of Gellivare. The distance from the gulf to the mountain by rail is 190 kilometers (kilometer = .621 of a mile); and it is anticipated that large shipments of ore will soon take place, both to England and Germany. At the present time, iron is chiefly mined in central Sweden, 87 per cent. of the ore being broken in the four provinces of Orebro, Kopparberg, Vestmanland, and Vermland, which lie together, forming one compact area, just north of the four great Swedish lakes. The best iron of all, however, is found a little to the eastward of this area. It comes from the celebrated Dannemora mines in the adjoining province of Upsala, where the old Walloon refining process is still exclusively employed. The number of iron mines in Sweden is extraordinary. In 1889, no less than 393 were worked, employing 6,278 labourers, and producing 983 bog tons of ore. Most of the ore was smelted within the kingdom, the small amount of 118,573 tons having been exported. During the same year there were 150 blast furnaces in operation. Here the ore was smelted, producing 416,043 tons of pig-iron, together with 4,622 tons of castings, which were run directly from the furnaces. From these pigs, 226,000 tons of bloom, and 136,000 tons of iron and steel ingots were refined, the latter by either the Bessemer or Martin process. From these blooms

and ingots, in turn, there were hammered out or rolled 275,000 tons of bar iron; 2,000 tons of steel were also manufactured by the old methods; and there were produced, in addition, 74,000 tons of plates, nails, rails, and other articles. In the various iron works of the country there were employed, in 1889, no less than 23,051 labourers. Sweden does not only manufacture the rougher forms of iron, but she also builds iron steamships of fine quality. There are several iron shipbuilding works in different parts of the kingdom, but the largest is at Motala, on the Gota Canal. Nearly all the steamboats plying on Swedish waters are said to have been built within the kingdom, and Sweden also sells steam vessels to other countries, notably to Russia, Finland, Germany, and South America. The Swedes have also become very skilful in the manufacture of cutlery. The town of Eskilstuna, lying not far from the western end of Mølar Lake, is now known as the Sheffield of Sweden. Here are established a dozen or more factories, which turn out the finest cutlery and tools.

PROCESS OF FIRING PORCELAIN IN FRANCE.

The United States Consul at Limoges says, in his last report to the United States Government, that the proprietors of the large porcelain factories there have been for a long time studying the question of reducing the price of fuel. At a recent congress of the manufacturers, it was said that some new and cheap way of manufacturing porcelain must be found for France, or the industry which has become so famous, and which employs so many of the inhabitants, would be driven from French soil on account of the cost of firing. It was there ascertained that the cost of firing china in Bohemia was not more than 10 francs a ton; in England it was only 13 francs, while, for the same thing in France, at Limoges, the cost was between 34 and 35 francs. This difference being so great, and making it impossible for the French manufacturers to make their china as cheaply as their foreign neighbours, various devices have been tried, but with little success. In order to compete, wages have been reduced to the lowest point, and still the manufacturers are said to have lost money. The coal that is employed is necessarily costly, as a smokeless, long-flame variety is required. Many of the factories burn wood only, as that produces a purer white than the very best kinds of coal, but wood is dearer than coal. It is consequently only used in firing the muffles, and in the finest grades of porcelain. A few years ago a new process was tried, that baked the porcelain in a short time; but the cost made the process impracticable. It was under such circumstances as these that one of the most progressive houses in Limoges was induced to employ petroleum or residuum oils as a fuel. To accomplish which, an American firm using the Wright burner was requested

to come and make a trial with the fuel. There was very much doubt and fear connected with the experiment; but, after a time, it was attempted, and the results were far better than anticipated. The heat was shown to be absolutely pure. No gases or smoke in any way discoloured the china, which came from the kiln much whiter, and in better condition than when it is fired with the best of wood. In the muffles there was a decided advantage. The delicate colours, which show at once the presence of the slightest quantity of gas, were perfect. "This new discovery," says Consul Griffin, "promises to revolutionise the whole porcelain industry." It is estimated that, by employing these oils, there will be a reduction of about 15 or 20 per cent. in the making of china. The only question now, is the present classification of residuum oils in the customs tariff, as the present duty on petroleum—120 francs per ton—is prohibitive; but strong pressure is being brought to bear on the Government to have fuel oils classified as fuel, which pays only 1 franc 30 centimes a ton. New life is given to an industry that was seriously threatened; and it is hoped that the French porcelain will be brought to a greater state of perfection by this new American invention.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

APRIL 15.—WM. TOPLEY, F.R.S., "The Sources of Petroleum and Natural Gas." PROF. CLEMENT LE NEVE FOSTER, D.Sc., will preside.

APRIL 22.—SIR GUILFORD MOLFSWORTH, K.C.I.E., "Bimetallism." SIR WILLIAM HENRY HOULDSWORTH, Bart., M.P., will preside.

APRIL 29.—WILLIAM ROBINSON, "The Use of Petroleum in Prime Motors." PROF. SILVANUS P. THOMPSON, D.Sc. will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoon, at Half-past Four o'clock:—

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Tuesday evening, at Eight o'clock:—

MAY 5.—CAPTAIN J. BUCHAN TELFER, R.N., "Armenia."

Tuesday afternoon, at Half-past Four o'clock:—

MAY 26.—C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

APRIL 30.—COL. J. O. HASTED, R.E., "The Periar Irrigation Project, Madras Presidency." The

Right Hon. SIR MONTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MAY 14.—THOMAS WARDLE, "The Use of Tussur in European Textile Manufactures."

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

APRIL 14.—G. T. ROBINSON, F.S.A., "Decorative Plaster Work : Stucco Work." T. ARMSTRONG will preside.

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

LECTURE I.—APRIL 13.—The elements of decoration—Choice of elements—Selection in natural foliage—Treatment not historical, but æsthetic and technic—Divisions of the subject—Realism—Botanical analysis—Disguised artificiality.

LECTURE II.—APRIL 20.—Education of nature—Preliminary studies—Avoidance of symbolic plants—Choice of normal plants—Clearness in composition—Avoidance of artificiality.

LECTURE III.—APRIL 27.—Conventionalism—Necessities in the representation of facts with imperfect means—Reduction : *in relief* to flatness, and *in colour* to monochrome.

LECTURE IV.—MAY 4.—Shapes and objects to which decoration is applied—Selection of plants to suit the shapes—Treatment in panels, borders, and diapers—Treatment on independent objects—Technical treatments.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 13... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Hugh Stannus, "The Decorative Treatment of Natural Foliage." (Lecture I.)
Lantern Society, 20, Hanover-square, W., 8 p.m.
Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. A. E. Pratt, "Two Journeys to Se-chuan and the Tibetan Frontiers of China."

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, APRIL 14... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. G. T. Robinson, "Decorative Plaster Work : Modelled Stucco Work."

Royal Institution, Albemarle-street, W., 3 p.m.
Mr. J. Scott Keltie, "The Geography of Africa." (Lecture III.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. R. E. Crompton's paper, "The Cost of the Generation and Distribution of Electrical Energy."

Society of Architects, St. James's-hall, Piccadilly, W., 7½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m.
Mr. W. Willis, "Platinotype."

Anthropological, 3, Hanover-square, W. 8½ p.m.
Mr. T. G. Finches, "The Types of the Early Inhabitants of Mesopotamia."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Mr. D. Morris, "The Colony of the Leeward Islands."

WEDNESDAY, APRIL 15... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Wm. Topley, "The Sources of Petroleum and Natural Gas."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Henry F. Blandford, "The Variations of the Rainfall at Cherrapoonjee, in the Khasi Hills, Assam." 2. Mr. Frederick J. Brodie, "Some Remarkable Features in the Winter of 1890-91." 3. Mr. H. Sowerby Wallis, "The Rainfall of February, 1891." 4. Mr. William H. Dines, "The Vertical Circulation of the Atmosphere in Relation to the Formation of Storms."

Microscopical, 20, Hanover-square, W., 8 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. C. Butterfield, "Explosives" (with experiments).

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, APRIL 16... Royal, Burlington-house, W.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Rev. F. R. M. Wilson, "Lichens from Victoria." 2. Surgeon-Major A. Barclay, "Two New Species of Puccinia."

Chemical, Burlington-house, W., 8 p.m.

Society for the Encouragement of Fine Arts, 8 p.m.

Conversazione at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly, W.

Royal Institution, Albemarle-street, W., 3 p.m.

Prof. Dewar, "Recent Spectroscopical Investigations." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Historical, 11, Chandos-street, W., 8½ p.m.

Camera Club, Charing-cross-road, W.C., 8½ p.m.
Mr. J. Howson, "Conventionalism in Colours."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, APRIL 17... United Service Inst., Whitehall-yard, S.W., 3 p.m. Colonel F. J. Graves, "The Reserve Question, viz. (1) The Ranks compared with Civilian Working-class Life; (2) Recruiting Difficulties; (3) the Condition of the Army Reserves."

Royal Institution, Albemarle-street, W., 8 p.m.
Professor A. W. Rücker, "Magnetic Rocks."

Philological, University College, W.C., 8 p.m.
Dr. Whitley Stokes, "The Metrical Glossaries of the Mediæval Irish."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. S. P. Thompson, "A Property of Magnetic Shunts." 2. Mr. James Wimshurst, "An Alternating Current Influence Machine."

SATURDAY, APRIL 18... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Silvanus Thompson, "The Dynamo." (Lecture II.)

Journal of the Society of Arts.

No. 2,004. VOL. XXXIX.

FRIDAY, APRIL 17, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES

CANTOR LECTURES.

Mr. HUGH STANNUS delivered the first lecture of his course on "The Decorative Treatment of Natural Foliage," on Monday evening, 13th inst. He dealt with the elements of decoration, and explained that his treatment of the subject would be æsthetic and technical, and not historical. He drew a broad distinction between artificial foliage, as used by the classic architects (which was not really copied from the real) and natural foliage.

The lectures will be printed in the *Journal* during the autumn recess.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 9, 1891; Sir STEUART COLVIN BAYLEY, K.C.S.I., in the chair.

The paper read was—

INDIAN VILLAGE COMMUNITIES, WITH SPECIAL REFERENCE TO THEIR MODERN STUDY.

By B. H. BADEN-POWELL, C.I.E.

Almost every educated person is aware of the fact that throughout India agricultural land is divided into certain local groups, called "villages" (in a sense different to that

in which the word is used in England). It is also, I think, commonly understood that the holders of these local groups form what are called "village communities." There must be some special interest in this fact, which accounts for so general a recognition. This division of land has survived all changes, though the owners and the form of holding have often changed; and a local name remains permanently on the map for each village. The causes of such a division or grouping are various. The formation of villages is not, however, quite universal; on the west coast, for example, and in the Himalayan districts, there are no villages: what are now so called are artificial aggregations of separate holdings—each with its own homestead—often scattered somewhat widely apart.

The idea of grouping holdings is as old as historic time. When we consider the conditions under which agriculture is practised in most parts of India, this will appear natural. The hard contest with semi-tropical jungle, which has to be rooted out, and the land kept clear, the depredations of wild animals (such as an English farmer can hardly realise), the presence of hostile neighbours, owing to clan feuds—all these would encourage, naturally, the connection of agricultural groups in some sort of union for mutual society, countenance, and protection. But the custom of joint succession (of the whole body of heirs together); the social custom by which each society seeks and employs its own separate body of artisans and menials; the fact that the collection of the king's revenue-share of the produce requires a local division of land, and a supervision of headmen of sub-divisions, these are perhaps the still more potent causes of village grouping.

So far, the "village" is an intelligible institution. If we inquire further about the general ideas prevalent on the subject, it would be interesting to know whence the ideas were obtained and how they became current.

The ordinarily accessible and generally read literature on the subject is inadequate, and often misleading. There has been a general tendency to take certain passages and copy them from one book into another, as if they exhausted the subject. These passages mostly are derived from the early published official minutes, written when the process of developing a suitable land administration was under discussion. After that was settled, the really valuable information ceased to become public, and went into Settlement records and official

reports. Some of these have been reprinted in issues known as "Selections from the Records of Government;"* but they do not get beyond the circle of official readers.

I think it will be useful briefly to sketch, though necessarily in mere outline, the progress of events regarding the discovery of local land-tenures, as far as they concern villages.

It is, perhaps, needless to remark that land-tenures were originally studied, chiefly owing to the practical necessity for discovering who were the proper persons to be made responsible for the land revenue assessed by a process known as a "Land Revenue Settlement." The person so responsible is always, in some degree, and not always in name (but still virtually), the owner of the land.

Now it so happened that our experience began in Bengal at a time when a number of persons (whose case I shall not discuss) were found to be in a position which was by law recognised as that of landlord, over large areas comprising many villages. The country was then largely waste; only about one-half Bengal was cultivated. But the cultivated area was divided into villages. These villages were of a type which presented no coherence; there was not, and probably never had been generally (except in the Bihár districts), that element which produces a united or joint claim to the entire village area—arable and waste together. The result was, that no attention was paid to the villages. No survey was attempted, no record of rights made. The position and privileges of the landlords, and the sum they should pay as ascertained from old revenue accounts, were alone discussed, and with them the privileges of a limited class of minor landholders.

Our next territorial acquisition (about 1765), in north Madras, was also, by a curious coincidence, found under "Zamindár" landlords; so the same Settlement was applied, and nothing new was discovered. But one of the tracts, known in these days as the "Jaghire" (Jágír), was not in the hands of landlords of large estates; and when other districts were acquired (in 1790-1801), it was also observed that there were no landlords, only villages; and they, as in Bengal, exhibited the same general absence of a joint-community element. How were they to be managed?

* I should like to urge that the time has come when a complete collection of these should be made, and the valuable historic papers reprinted; otherwise they will be totally lost. It is now impossible or very difficult to get a sight of some of the early papers which have the greatest value.

It is difficult for us, with all the light of modern knowledge regarding the history of property and of ancient institutions generally, to realise the views of the revenue officers in the last century. Their only idea of landholding was that there must be a landlord for each estate—whether a single village or half a district—and that every one on the land was the tenant of that landlord. In Madras, in the districts spoken of, finding no such landlords, they actually proceeded to make the villages into groups or parcels (called *mutthá*), and sold them by auction, the purchaser becoming landlord, and responsible for the revenue! Such a system was, of course, doomed to failure; the purchasers nearly all broke down and gave up; but to this day some relics of the old *muttháddars* still survive. Meanwhile it was observed that in the Chingleput district (part of the "Jaghire"), there were traces of village bodies, unlike the rest. Mr. Lionel Place, one of the early Collectors, actually succeeded in making Settlements with these bodies, and they worked fairly well. But the "one-landlord" idea was still too strong; the controlling authorities had, indeed, their attention drawn to the villages as units, but they wanted to arrange village-leases to some one person for each. The result was that a general inquiry was undertaken. It then came to light that in several districts—not generally, but sporadically (and only in the one locality above-mentioned more uniformly)—there were villages in which a class was found now much decayed and depressed, but still nominally claiming the whole village in shares, and calling their right *kāni-āthī* or "birth-right." This term had also become familiarised in the Persian office-language as the *mirās* right, and the co-sharers were called *mirásdār*. There can be no real doubt that this was a relic of a constitution resembling that of an Upper Indian village, where a *body* claims the entire village area on a certain scheme or principle of sharing. The evidence still exists; and part of it (notably the Memoranda of Mr. Place and Mr. Ellis) was reprinted at Madras in 1862.

I shall have to allude to this subject again, but here I will only add that, such cases being only exceptional, and even then hardly in practical working survival, it was found best to adopt the method of revenue management known as *rai-yatwári*—the system which deals separately with each holding in each village.

But while this was going on in Madras—indeed, at the very beginning of it—Warren

Hastings had acquired—perhaps by questionable means—in Bengal, the territory known as the “Province of Benares” (now under the North-West Provinces Government). In 1795, this province was permanently settled under the Bengal law. But the circumstances did not suggest a Settlement of the whole group of districts with the Rájá as one estate. By agreement, the Rájá was left with his own ample private lands and large allowances, and the Settlement was made with the villages, and in some cases with minor chiefs over villages. In Benares, unlike Bengal, but more like Bihár, the villages were held by strong bodies of higher military caste. Their curious constitution was described in the very earliest report on “village communities” I have met with—a report by Mr. J. Duncan, the British resident at the Court of Benares (1795-6). This Settlement was still of the “one-landlord” type, to some extent; for the eldest, or head sharer, was treated as the landlord, and the others were subordinate; but all were rendered jointly liable for the revenue. The tenure was that curious form called *bhaiáchára*, a term which, as we shall see, has since been unfortunately perverted from its proper meaning. But our acquaintance with village bodies was not destined to end here. A few years later, the necessities of the Oudh ruler induced him to invoke British aid for his defence; and to meet the heavy cost, he “ceded” a number of districts, all round what is now Oudh. In 1803, also, a number of other districts were conquered by Lord Lake from the Maráthás.

The North-Western Provinces* were formed out of these two groups, together with Benares; and, 30 years later (in 1834) they were placed under a separate local Government.

When these districts came to be “settled,” the proposal was to adopt the Bengal law; but various circumstances fortunately prevented its accomplishment. It was unavoidable to provide for some years of preliminary, tentative, revenue arrangements; and before this period had elapsed, the Government at home (probably enlightened by the Madras experiences) had become aware of the objections to a hasty “permanent” Settlement. They prohibited such a system for the new province, and called for an inquiry into the real facts of tenure. A special Commission was appointed to make a Settlement, and the

Commission was soon made permanent as a “Board of Revenue.” In the course of time, the Commission had the good fortune to get Mr. Holt Mackenzie as its secretary; and in 1819, this gentleman wrote a long and very valuable minute, which resulted in the passing of Regulation VII. of 1822, and the inauguration of a new era in Settlement policy. Above all, a complete survey, and an inquiry into and record of, all rights and interests in land, was made part of the new system.

This led to the discovery of the general prevalence throughout the province, of village communities of the joint type.

When the Panjáb was annexed in 1849, its Settlement was undertaken on the same model; and there also, though (generally speaking) under different historical conditions, village communities were found to be even more general, and perhaps still better preserved.

Turning now to Western India, the Bombay territories were variously acquired; but the bulk of them were ceded in 1818, after the last Maráthá war. For a considerable period nothing was done towards a regular Settlement. When the Hon. Mr. Elphinstone was Governor, he had taken to heart the idea of the North-West Provinces village-Settlements, and an inquiry into village tenures was set on foot, with a result somewhat similar to that obtained in Madras. Omitting from notice the coast districts (which present peculiar features not within our present scope), the bulk of the Dakhan districts consisted of villages which, as in Madras and Bengal, had a certain bond of local union, but not that element which I take it is essential to the idea which most people have of the village community, namely, a joint claim to the whole area of each village on the part of the cultivators, or some class of them. Two phenomena, however, of great interest presented themselves. The first was observed over a somewhat wide area; the second was wholly localised, and special to parts of one or two districts only. The widespread feature was, that in a considerable number of villages the cultivators were distinguished, some by the name of *uprí*, others as *mirási*; there was also a term applied to certain holdings—*gatkul*, which ominous term indicated that the old hereditary family was lost or had disappeared. It is, however, evident, on grounds I cannot now go into, that these villages represented the dismembered remains of estates or domains once held by chiefs in the time of the early Maráthá domination since destroyed, before the later and

* So called because they then formed our north-western frontier, being north-west of the Bengal Presidency.

general development of Maráthá rule under Sivaji and his successors.

The second feature was that in some parts of Guzarát were found—and these still remain—a few fairly perfect specimens of joint villages known as the *bhāgdāri* and *narwāddāri* villages, or, in Bombay official language, “shared villages.” In these all the features of the Upper Indian joint village exist. It is known that these villages are the fragments of a Rajput tribal conquest. These two features were, therefore, the one quite exceptional, and the other not practically in survival; looking, then, at the general and existing state of things, it was concluded to adopt the *raiyaṭwāri* system: the few cases of really joint villages are easily provided for under that system. I may add that the Bombay system was not, at first, a success; but after some years it was, by the genius of Wingate, Goldsmid, and others, elaborated into one of the simplest and most easily-worked of our Indian systems. In 1879, the whole was consolidated by the passing of a Revenue Code (Bombay Act V. of 1879), an Act which will compare favourably with any of the Land Revenue laws on the Indian Statute-book.

The other provinces I may pass over, except so far as to say that Berár and the Central Provinces also exhibited no trace of joint villages. In the Central Provinces, you are probably aware that the Government of the day created landlords over the villages by allowing the head-men, or revenue-managers, to become proprietors—but in a limited sense, and with reservation of the practical rights of the villagers. So that now the Central Provinces exhibit the curious spectacle of village landlords who have no control over a large part of their tenantry; the rents being fixed by the Government officer at Settlement.

But what is more especially to our point, the landlord thus put over the village will, in the course of years, become replaced by a number of sons or grandsons, who will jointly hold the villages. As long as they remain undivided, they will form what the North-Western Provincial language would call *zamindāri-mushtarka* communities. They will, as a body, hold the entire village; while each will have his own *ṭikā*, or home-farm, the rest of the village—probably largely held by immovable tenants, with occupancy rights—will no doubt remain undivided, as far as the landlords are concerned; and there will be joint profits from the jungle produce, house fees, &c., to be divided. In short, this body will reproduce all the

features of the older communities, and represent the manner in which a large portion of them actually came into existence.

If I now revert once more to the ideas, which, from books and otherwise, I understand to be generally prevalent, I think I may not be wrong if I summarise those ideas thus:—That the “village community” is a feature common to all India; that it is represented by a joint ownership of the soil, and something like a communistic association; at any rate, it is an unchanging or stable, self-governing, self-contained group. Further, that this institution is primeval, *i.e.*, the earliest of all. In process of time, and as a stage in the progress of property, the joint group divides into major and minor shares, in which state it is called a *ṭattidāri* village. At a still later stage, the shares become altered and lost, until a severalty holding, dependent only on the accidents of *de facto* possession, is the rule. This represents a final stage in the individualisation of land-holding.

It will be, perhaps, interesting to compare this general belief (as far as it, or some part of it, has been correctly represented) with the results derivable from the brief sketch just given of the history of our different discoveries in land tenure.

First, it will have struck you that, taking a wide view of the larger provinces, there is a vast area in which the grouping into villages is a conspicuous feature, and yet there is no bond of proprietary union within the villages. The cultivators—each family on its own fields—are tied together by some social or local bond, but not by a joint claim to an entire area in a ring fence, arable and waste together. The waste adjoining the village is used for grazing and wood-cutting, but the villagers do not think of it as their own, to be divided up at their pleasure when occasion arises. There are other marks which distinguish this constitution of things, but what is said will suffice for our immediate purpose. I will call this class of village (A) the *raiyaṭwāri* class.

Then, I may remind you, we found, in Madras and Bombay, traces representing an occasional and local uprising of a body in the village which did claim the whole. While villagers of Class A held on the (ultimate) claim of having cleared and reclaimed the holding, these others claimed it as their “birthright,” which is a euphemism for the conquest, or usurpation, or growth by superior ability, which (in their forefathers) gained them

the predominant position. Exactly the same growth of landlord bodies occurred in Oudh, only on a more uniform or compact scale, because the area is smaller, the land nearly all valuable and culturable, and the old kingdoms smaller. There was in Oudh, in short, the most favourable opportunity for the more frequent growth of families, and so landlord bodies grew up in a large number of the villages. They often fell again when the Taluqdār landlord arose, but that we are not concerned with. Exactly the same state of things—varied with other causes, and with some smaller tribal immigrations—occurred in the North-West Provinces. In short, in these cases the joint community formed by a landlord class (whether itself agricultural or non-agricultural) has grown up either sparsely, or more uniformly, in, over, and among the pre-existing *raiyatwārī* villages. I call this class the joint-village (B). I will return to it presently; but I wish at once to call attention to the Panjáb.

This province had a different tribal history to the countries we have reviewed, and therefore there has been a different origin to the prevalent village communities. It is true that the great tribes which produced the special effect I speak of, did some of them wander down to the North-West Provinces and Oudh, and carried their ideas with them; but it was only as the last ends of a stream, and in comparatively small numbers. The effects, therefore, of settlements of the tribes in those provinces, represent smaller and localised features taking their place among other features: whereas, in the Panjáb, where they settled *en masse*, the result gives the preponderating, if not quite exclusive, feature to whole districts.

The tribes who then occupied the plains of the Panjáb were distinct from those Aryan immigrants who brought the Vedas, and all the social and dynastic peculiarities of Brahmanic society. And they always—as conquerors, and, moreover, as agriculturists and cattle-grazers, and adepts at village-founding—formed strong village-bodies in whatever form of co-sharing. They were, in fact, all villages of Class B. It is certainly the case in the Panjáb, that we cannot, as we can elsewhere, describe this class as supervening upon any pre-established land organisation such as Class A. If ever there was such a class, which is hardly likely, it totally disappeared.

The Hindu-Aryan policy was never (originally) established in the Panjáb plains. In the Himalayan hills it was. And if the Porus who

fought Alexander was a Rájput prince, and not a “Hinduised” Dravidian, his kingdom was close to the hills about Jihlam and Ráwalpindí. Afterwards, no doubt, a number of Rájput leaders, or small groups, wandered back into the Panjáb, and formed groups of villages, but this detail I cannot go into. Speaking of the general Aryan advance, the people, as we know from their own texts,* regarded the Panjáb plains as “impure;” and when at last they issued from their hill domains, it was to the upper part of the Ganges plain, first near Delhi, at Hastinápurá. The Panjáb may then have been largely unoccupied, or held by some early tribes, who were overcome, and mingled with the new-comers. At any rate, another swarm, or probably successive swarms, of whom the Jat and Gújar tribes are the prominent representatives, settled in the country. And there is a marked distinction between the Panjáb frontier districts and the Central Panjáb; the two portions were both colonised by different tribes, who all formed joint villages. Hence we have *two* opportunities of studying village growth, the frontier immigration being of much later date than that of the Jats and Gújars to the central Panjáb.

Whether the Jats and Gújars are, ethnically, of Aryan stock, or are Scythic, or Sáká, or what, I do not discuss. Probably the Jats, as we know them, are not all of one origin; but they had occupied the Panjáb, roughly speaking, below the Jihlam River, before Alexander's time. The Greek writers mention tribes having no kings or princes, but governed by *pañcháyats*—to use the Indian term—of elders, or heads of families. They came as conquerors, and though I am not aware of the use of the term “birthright,” or *mirásí* (as in Southern or Western India), they always talk of their ancestors “founding” the village: and they have a joint constitution and a well-understood claim to the whole of their village areas, whether waste or tilled.

The frontier tribes are, on their edge, somewhat mixed (as might be expected) with Jats and Gújars; but otherwise they are quite distinct. When we cross the Jihlam we find, for example, the Ghakkars—a tribe which had some historic importance: they and other such clans call themselves *Sáhu*—the gentry or landlords, as distinct from the other castes, who are mere Jats, or zamíndárs—plough-drivers. Further north still, there are a number of smaller tribes of Afghán

* See Muir, “Sanskrit Texts,” vol. ii., 482, &c.

origin, who only came in in the 12th and later centuries of our era. All these tribes exhibit, first a tribal location, in larger groups called *ilāka*, and then the subdivision into villages; they never, as far as my study goes, held in common, but always at once allotted the lands into clan, and then into family and individual, holdings. Still, in a sense, the villages are joint, for they have the conqueror's landlord feeling over the whole area, including their waste; and they also recognised the principle of periodical exchange of holdings. All the evidence I have collected points to this exchange being for the primary or immediate purpose of equalising the advantages of holding, and not allowing one set of families to get all the best, and another set to get all the worst, permanently. But it may well be argued that indirectly, at any rate, this exchange indicates a kind of sense of tribal or general right—the families or individuals are not yet bound to take, once and for all, what fortune gives them: inequality can still be redressed, because the collective ownership of the whole tribe has not yet been forgotten. I may note that this exchange is found in the Central Provinces, and sometimes in quite modern cases of village formation, and it is always connected with the equalisation of advantages.

The reason, then, why the Panjāb does not exhibit the feature of growth of landlord villages over the *raiyaṭwāri* organisation, is intelligible, as it is special.

But it still remains to ask, may it not be that where the *raiyaṭwāri* village is now the form over wide areas, it was once a joint-village (like Class B), and has decayed?

In reply, I should say that a series of reasons combine against the supposition. In the first place, whenever we find more or less distinct traces of the landlord village in the midst of the *raiyaṭwāri*, we are possessed of evidence as to the origin of such villages, and are not obliged to suppose that they are mere relics of a universal form, which for some reason remained in some places, while it had disappeared in others. A good example is afforded by the Madras case already referred to. I mentioned that the *mirāsi* claims were found more particularly in one locality. It so happens that, we have historical evidence on the subject; the district was the scene of a somewhat extensive colonizing adventure sent out by one of the Chola princes. Doubtless, the leaders and principal men having, as it were, a charter, and having borne the risk and

labour of clearing and founding the villages, conceived themselves as the lords of the soil, and in a different position to the older cultivators in the districts around. Another reason is that the *raiyaṭwāri* village (Class A) has a structure of its own, in no way suggesting a modification of the "joint" form. In the first place the headman (*pāṭēl* is the old Hindi title) is a central figure of great importance. In the joint village (Class B) there is no headman; the *lambardār* of our present Revenue rules is, as his hybrid title suggests, a modern administrative creation. In the joint village (B) we have always a co-sharing body (whether holding in severalty or not) of the superior, perhaps military, at any rate more energetic, caste, all either directly descended from one ancestor, who founded or acquired the village; or they may be a group of connected families located together. Such co-sharers are generally disposed to be jealous of any one of them getting the lion's share, or becoming too powerful; their ideal of management is a representative council (or *pañchāyat*) of the heads of families. It is a sure sign of modern influences, if not of actual decay or change, that these *pañchāyats* have now lost much of their power, and do not habitually assemble; and the government headman, or the village accountant (*paṭwāri*) have, in some cases, acquired influence in their place. Now in the *raiyaṭwāri* village, the *pāṭēl* with his family all use the title, and jointly enjoy the official holding of land attached to the office (*watan*), wherever the ancient institution survives. He directs cultivation, settles disputes, and interferes in various matters in a way that a co-sharing village would never allow. His family owns and occupies the *garhi*, or largest central house or castle of the village residence, and in days past he often stood up for the defence of his village, and made the *garhi* a veritable little fortress.

The fact that a body of menials and artisans, specially serving each village, is a form common to both classes of village, is dependent on the social ideas of the people, and their class customs; it has evidently nothing to do with the question of land-holding, or its form.

When, moreover, we look to the historical circumstances of those parts of India where the *raiyaṭwāri* form most prevails, we can ascertain that there were no causes which would have produced a complete and widespread change of form. Adventurous bands of north-western tribes came here less; the rule of the Muhammadan kings was favourable

to old institutions; the Mughal empire had but little practical hold, and for a short time only; while the Maráthá rule, grasping as it was, tended to prevent the growth of families,* which absorbed the rights and diminished the revenue profits of each village. The uniform levy of revenue might tend to destroy privileges and distinctions which depended solely on comparative freedom from payment, but that is all.

But perhaps the most potent reasons are (1) that the *raiyatwári* form of village is the only one known to Manu, and alluded to in the *Institutes* (*Mánava dharma sástra*); and (2) that the *raiyatwári* form was essentially that of the old villages in Dravidian countries. It is surprising to find one book after another copying without inquiry the statement—if, indeed, they mean what the words imply—that the village, as a “joint community,” was known to Manu. I have again carefully examined the best version (Dr. Bühler’s), and if any one will show me any line or phrase that indicates a village being held by a joint body of co-sharers, who were “founders-kin,” or conquerors and “birthright” holders of it in common, under a council of family heads, I shall be much obliged to him; that is the least I can say. Whatever the actual date of the book, the *Institutes* may be supposed to reflect the ideas of the time, which was one when the Aryan rájá, with his learned Brahman counsellors, was well established, and probably had finally amalgamated with the preceding Dravidian inhabitants. The districts were divided into jurisdictions over “100 villages,” over “20 villages,” and over “10 villages;” and the idea of land-holding is the separate right of each man, or rather family, (for the joint succession and family ownership is recognised) who had “first cleared” the holding from the primeval jungle. Manu is familiar with the group of such landholders, under the control of a single headman or chief, who is part of the State organisation, as well as of the social, and who looks after the king’s share. Everything Manu says—and to be sure it is not much—answers to the *raiyatwári* village, with its hereditary *pátél*, and not to the joint village of the North-West Provinces and the Pánjáb.”

As to the second point, Mr. J. F. Hewitt

read in this place an interesting paper about the Dravidian forms; and I must, therefore, only briefly touch on the subject. Passing over the loose organisation of the early Kolarian tribes (who appear to have been chiefly practisers of the shifting cultivation known as Júm, Kumri, &c., in parts of India, and Taung-yá, in Burma), it may be noted that, whatever the real names and origin of the (so-called) Dravidian tribes, they were not the scanty and barbarous population, obliterated and driven out by the great wave of Aryan conquest, which is apparently the supposition of many. They were a powerful and wide-spread race, or series of tribes, who had strong central, but local governments, under princes and “feudal chiefs,” and a regular land revenue, at first taken from a special “lot” in each village, and afterwards from all lands, except certain favoured “lots.” Their institutions still survive in Chutiyá-Nágpur, Orissa, and Central India, where Mr. Hewitt had excellent opportunities of studying their history. Gondwaná was one of their great kingdoms; and the so-called “Zamindari” estates of the Central Provinces are held by Gond chiefs, relics of the old state of things unchanged by Maráthá domination. They also (witness the Bhár tribes) occupied Oudh and the North-West Provinces, and perhaps extended further north; certainly they are found in the Kúch tribes of north-east Bengal and Assam. They were a literary people; and some of the peculiar letters of the Sanskrit alphabet are derived from them. These people were partly, but only partly, conquered by the Rájputs, far more frequently by the astute policy of the Brahmans, these races formed political and social unions. The Dravidian princes accepted Brahman councillors, took Hindu names and caste, called themselves Rájputs, and had invented for them fanciful genealogies traced from the heroes of the *Mahábháratá*.

Their village institutions, which now concern us most, still survive. They were essentially *raiyatwári* in kind. The central feature of the organization, as regards the people, was that each village had a certain family group known as the *bhúinhár* or aboriginal clearers and settlers of the soil. Out of these the hereditary headman was chosen: his place was in time rather usurped by the *mahto* or Royal headman, put in to look after the king’s interests. As regards the land, the main feature was the division of the area into lots, one for the *bhúinhárs*, one for the *mahto*, one for

* There were, of course, exceptions; but in outlying districts, where the hold of the Maráthá power was insecure there, and there only, they gave out farms, and then exceptionally (as in the case of the so-called Khot families in the coast districts), they grew into landlords.

the priest and religious service, one for the king (*majhas*): but the remaining area was held by ordinary less privileged soil-tiller. The only change that such a form undergoes before it exactly resembles the *raiyaṭwāri* as we now see it, is, that by the levy of a uniform (and not light) revenue by Muhammadans or Maráthás, the distinctive privileges of the lots became levelled; the only lot that escaped was that of the headman, which, with the Muhammadan kings, was called by the Arabic name *watan*, and which was rarely, if at all, respected in the districts that felt the full force of the Maráthá sway. No wonder, then, that generally the old type of village remained, and only a few places witnessed the growth of "mirási" families.

But in the North-West Provinces and Oudh, assuming that the Dravidians and mixed races had generally established the same form to begin with, the Rájput and other tribal conquests resulted in the much more frequent and uniform uprising of proprietary families in each village. Moreover, when we now see a large tract entirely occupied by joint villages, and it is not a case like the Panjáb, we have to bear in mind that, in a century or two, quite a small centre of landlord-villages, will expand and throw off numerous shoots and "secondary" villages in the waste all round; so that if we only regard the present state of things, we might suppose that we were looking at a really numerous tribal or clan settlement. The Rájput race is extraordinarily prolific, and in my forthcoming work on the land systems of British India, I have given several instances, both in North-West India and the Panjáb, of extensions from small centres in this way. Here I will only allude to one notorious case—the Rai-Bareli district of Oudh, where 1,719 villages variously aggregated, are all known to be the offspring of one central, and, at first, limited, location of the Rájá Tilokchand.

It is worth while to examine a little further the way in which, in the North-West Provinces and Oudh, the joint, or landlord village, grew up over the *raiyaṭwāri* villages, and extended to the still unoccupied waste country around. The Panjáb, as I have explained, owes its joint villages to other tribal conditions.

I will commence with Oudh, because Mr. W. C. Bennett, C.S., has fully explained to us the evidence that remains of the old Rájput kingdoms, and how the individual villages were originally *raiyaṭwāri*, and how in them, powerful families, scions of the Royal house, Brah-

mans, Khattris, and others, got the lead, and produced (in time) a body of jointly owning descendants, claiming the whole village, and changing its original constitution.

Nothing is more curious than to observe in these districts, the action of the Rájput conquerors as distinct from that of the Jat and Gújar tribes in the Panjáb. And, generally, we can observe two distinct forms of organisation—one in which there were princes and chiefs, and the tendency of descendants was to cling to the ancestral principle of sharing; the other where the tribes were, as within themselves, democratic or "republican," as some authors have called them, and adopted a different principle of dividing land. In will be more convenient to mention this again in another connection. Here I want to make it clear how the joint village grew up. The old Ayran (Rájput) kingdoms of Oudh were just such as Manu indicates, and as Colonel Tod (in his *Rájasthán*) so enthusiastically describes. When they were established by conquest, their leaders were content with the ruling position, or, according to rank, with minor chiefships and the official rulership over groups of villages. And they, therefore, at first did not interfere with the nature, and form, and expansion of the ordinary *raiyaṭwāri* villages, which existed and continued to grow when their rule was established. But when misfortune overtook the royal and noble estate, the family members quarrelled and split up, or when wars, so frequent in those days, dismembered the estates, the members of the family had to descend from the ruler's place, and fastening on to, or managing to retain, single villages or small groups, they came into close managing contact with the land, and became landlords, giving rise to the bodies who later formed the communities of owners. Nor was such growth only the result of disruption of rulers' estates. We find many cases where the Rájá or the chief made a grant of his grain-share, or of this united with other privileges in a village, and the granter's family grew into a proprietary body. In many cases, leading families simply managed to usurp their position gradually. When revenue became commonly taken in cash, a manager in the village became increasingly wanted; and we can often trace the growth of such managers' families; indeed, in Oudh, that unfortunate term "Zamindár" has this (exceptional) meaning; it refers to the right of holding a lease for managing and collecting the dues and profits in a village under a Rájá.

Exactly the same thing happened in the North-West Provinces, varied more frequently by the establishment of groups of Jats and Gújars from the Panjáb. But in these provinces there is one feature which is worth notice. It is perhaps not generally known that a very large proportion of the existing village-communities are due to our own early revenue system, when the rule was to farm villages to a single responsible manager; and when villages were so often summarily sold for (supposed) arrears of revenue. The farmers and purchasers became first the sole landlords, and now (after only a century) are represented by considerable bodies of co-sharing descendants, who doubtless talk grandly about their *ancient* rights.

If under all these various influences, a certain number of the villages escaped the landlord growth and remained *raiyatwari*, or if formed by later colonists on that principle, they have now, under our revenue system, become joint-villages, by reason of their accepting the (nominal) joint-liability for the revenue, which was made sweet by the absolute grant of the adjoining waste (nearly always valuable).

While these things are borne in mind with reference to the idea that the joint-village is primeval, and the separate holdings a later development, directly from it—a matter on which I shall have a little more to say presently—it is right to observe that, though the form of village in itself is in many cases not archaic at all, and in others not the oldest form, still the whole principle of formation depends on a truly archaic survival, the joint-succession. If it were not that property is looked on as belonging to the whole family, the sons or other heirs would not succeed together, and so form a joint-body, till they agree to divide, and even then do not lose all bond of union. And this may be held to follow on a still earlier idea of ownership by the tribe. Even the Dravidians had a tribal organisation above the village, and the *nádu* of Southern India, as a local grouping, is the tribal union under a superior chief.

If I may now summarise what has been said of the origin of village (joint) communities (Class B), I put it thus:—

First, the term “community” can only be used of *one* very large class of villages, in a restricted sense, implying a connection of locality, and having, in common, the services of a body of artisans and menials.

It is more properly or especially adapted for use in *another* form of village which has a

proprietary class, having a joint sense of ownership over the whole area, whether the area is actually partitioned for several enjoyment or not. Even then, there is nothing like a “having all things in common.” Each man or family has his own home-farm, pays his own share of the burden (though he may be called on by the State to pay up for a defaulting member); he also takes his own share of miscellaneous profits that accrue to the estate as a whole. Common business was originally transacted by a council, but this institution is now much on the wane. Strangers are only partially kept out of the group by exercise of the right of pre-emption when a co-sharer wishes to sell his land; it often happens that the others do not care, or cannot afford, to exercise the right.

Communities in this sense arise:—

I. Uniformly, and where there is no preceding form of village—as in the Panjáb.

(a.) By tribal conquests of large bodies as the Jats, Gújars, &c.

(b.) By return or reflex movements of small parties, single adventurers, &c., who finding no place in the first settlement of their clan, wander back, obtain a site to settle on, and end by multiplying into a more or less extensive group of communities.

II. Communities grow up over, and multiply among, an earlier form of village (more or less sparsely or uniformly, according to local and historical circumstances).

(a.) By tribal conquest, where, owing to smaller numbers or other causes, the conquerors are content with the ruling position over the country; and where the original village constitution is not affected until (as time goes on):—

1. The rulers make grants, and the grantees multiply into landlord bodies over the villages.

2. Leading families acquire the same position, without any distinct grant.

3. The principalities break up, and the scattered and divided members of the noble houses descend from the rulers' seat, and retaining hold on individual villages—fragments of the once larger estate—become landlord communities over them.

4. A large number of villages acquire a landlord (and, in time, a joint proprietary body) by the growth of a revenue farmer, or purchaser at a sale for arrears of revenue.

Observe that in it is these four cases, that first an individual right, then a joint holding, follows, and that this, in time, becomes a divided severalty holding.

III. Communities are formed by our own Revenue system where they did not really exist before.

(a.) Villages were formed by co-operative colonisation of people in virtue of a charter, or without any authority, waste land being abundant. They may, or may not, have an idea of joint ownership over a fixed location; they often held according to the "ploughs" each brought, or according to shares in the wells they wished to sink.* Sometimes each settler took whatever land pleased him, or he could manage.

(b.) Villages were of the old *raiyaṭwārī* form, and escaped the growth of any landlord class; but, under our system, were treated as joint—given an area of waste, to be jointly enjoyed. Such villages are now called *bhaīāchāra* (an example is afforded by the artificial village in the Kangra district of the Panjāb).

I must now invite your attention to a most important point, and one on which I hope the influence of this Society, so often exercised for good, may avail to produce a remedy.

I allude to the total absence of all rational statistics of village tenures in Upper India, where the community form prevails, and where the origin and present condition exhibits such curious and interesting varieties. To this fact, more than to anything else, I attribute the general want of information regarding villages, and the purely conventional type of the prevailing ideas as the subject.

When the Settlement proceedings in the North-West Provinces had gone on for some years, Mr. Thomason gathered up the results of experience, for future guidance, in his well-known "Directions to Revenue Officers," and in this work he suggested a classification of the joint-villages (for official purposes) into:—

1. Villages (or estates) held by a single landlord, or by a body of undivided family members (*zamindāri-khālīs* and *zamindāri-mushtarka* respectively).

2. Held with the shares divided for several enjoyment, according to the ancestral, fractional share, according to the place in the "family tree" by the law or custom of inheritance (*ṣattidāri*).

3. Held in divided lots, but not on ancestral shares, but on some other principle, or perhaps on no principle at all, but on the accidents of *de facto* possession (*bhaīāchāra*).

And he added two other classes as pendants

to 2 and 3, called "imperfect," *i.e.*, where part only and not the whole of the land had been divided out for several enjoyment.

Mr. Thomason, however, explained that he did not regard this as a final classification; he suggested that a classification according to the principle of allotment or enjoyment, was desirable. This important fact has, unfortunately, been entirely forgotten.

The first classification was adopted generally, and is still kept up. In early days it may have been of some use, just as the old Linnæan system of botany was—better than nothing; it is, however, utterly unsuited to modern requirements, and—as usual with designs that contain the elements of error—has grown much worse in actual use.

One of the grave original defects, however, is the use of the term *bhaīāchāra* to indicate, not the curious and quite special principle of allotment, which is its real meaning, but to signify (confusedly) any kind of allotment—whether with principle or without any—so long as it did not depend on the ancestral share, or *ṣattidāri*, principle. In this confusion you perceive the burial and obliteration of all those distinctions and characters which are just the very things worth studying and knowing.

Another grave defect is the "imperfect" class, at any rate, as it is now used. It distinguishes a matter that is of no interest, because a number of quite unimportant accidents may cause a portion of the land to remain undivided. For example, the large class of cases where occupancy tenants hold part of the village. Their rents are taken to pay the Government revenue; and there is no object, as far as the landlord is concerned, in dividing the land. But if all villages—and usually all are treated alike—which happen to have this one feature in common, are lumped together, all their real differences of constitution are lost sight of.

I do not think I am wrong in attributing a portion of the prevailing ignorance as to the real facts of village constitution, to the absence of any real statistics or a census of villages.

The Government of India periodically furnishes the Secretary of State with (provincial) tables of agricultural and tenure statistics, which are printed in a "Blue-book." The latest of these in my possession is dated 1886-7; and, looking to the tables of tenures, which might be so instructive, I find them, on examination, to be quite useless, and also misleading. Nor can they be reconciled with other accounts found in reports, &c.

* The "well" is always held to include not only the water-shaft, but the area of land watered, or, at least, protected, by the well.

Having just now alluded to the misuse of the term *bhaiāchāra*, I should like to explain the subject a little further.

It is primarily connected with the subject which I reserved for further mention, namely, the curious fact of the different constitution of tribes, or clans in tribes. Some of the Rājputs and others possessed a feudal organization, as we call it. There were Rājās, and lesser chiefs (*Thākūr Rānā*, &c.), in a graded order; and when (as we have seen), by disruption of a ruling estate, or when cadets of families and others, separated, and village estates and communities were formed, they always adopted the ancestral plan of dividing, *i.e.*, the sons of a chief, &c., took shares according to the law of inheritance—say, three sons, one-third each, and six grandsons, one-half of one-third or one-sixth, and so on. You have only to draw up a genealogical tree of the family, to tell at once the fractional share of any given member.

No doubt time and accident usually caused the shares to be modified; but the principle may yet remain constant, because though the landholdings may have got out of proportion to the shares, other profits—the waste land and so forth—may still be divided according to the ancestral shares.

And one of the facts which a true statistic would show us would be to distinguish Pattīdārī varieties:—

(a.) Villages where the shares are comparatively perfect, at any rate the principle is fully recognised.

(b.) Where shares are modified as regards the area of landholding, but remembered in other respects—in dividing profits, waste land, &c.

(c.) Where they are lost, but the village declines to record the existing holdings as permanent, because of a feeling that the true shares may be restored at some time or other.

(d.) Where they are wholly lost, and the village accepts the fact, and records, finally, the holdings, *de facto*.*

But sometimes, and we should like to be able to say why, the clan had neither Rājā nor other ruling chiefs; the common descent and united feeling, when settled in a tract of country, were all strongly in evidence, yet they paid no attention to the "family tree," but divided the land to all equally; and often invented a curious method of dividing the land so as to ensure the equal value and advantage of the holdings. They took as the standard

what is called the *bhaiāchāra bighā*, an imaginary or artificial square measure, not at all the same as the common or standard *bighā*,* but a holding composed of several bits of each variety of soil—of course scattered about over the village, or some division of it. Thus one family did not get all the good and another all the bad.

Another plan was to make the *bighā* of good land smaller than the *bighā* of bad, so that when the revenue burden was distributed, it was not the best soil paid a higher rate, but the payment-share corresponded to a smaller lot of good land, and a larger lot of inferior. These methods were sometimes accompanied by a custom of annual or periodical redistribution of the revenue, so as to make it correspond with the actual advantage of the lots; this was called *bhējbarār*. I have not time to describe it further.

It will be observed, then, how absurd it is to talk of *bhaiāchāra* (in the real sense), as a stage beyond *pattidārī*, or ancestral sharing; both co-existed.

Note also, that in some cases of *pattidārī*, and all cases of real *bhaiāchāra*, no stage of joint holding (in common) precedes the allotment; on the location of the tribes, the lots are made at once, and from the tribes.

It is only where the landlord right begins with one holder or founder of some eminence, and then falls into the hands (in the course of time) of a body of descendants—joint heirs—that the village is held in common for a time, and divided into *pattis*, or shares, at a later stage.

And, as regards the other classes, which are confused under the term *bhaiāchāra*, they also mostly represent a custom or mode of allotment which was never preceded, as far as any evidence shows, by a holding in common. The only exceptions are those villages (to which *bhaiāchāra* is applied only by a flagrant abuse of language) where they may have been first joint, then *pattidārī*, and then the shares wholly lost.

Under *bhaiāchāra*, as now wrongly used, we must distinguish—

(a.) Real *bhaiāchāra* villages.

(b.) *Pattidārī* villages, where the shares, according to the proper practices, have been forgotten.

(c.) Where it is questionable whether we ought to talk of a "principle of sharing" at all. A co-operating body of colonists has founded

* Note that under our prevailing methods, this last class (d), and possibly (c) also, would be comprised under *bhaiāchāra*.

* The *bighā* varies in different provinces; Akbār's standard was 60 *illāhi* yards each way = about 5-8ths of an acre.

the village, holding it according to the number of "ploughs" (and the land worked by each plough*) that each possesses, or according to the "wells" (and the land watered).

(d.) Where there are no shares at all. The land held according to each person's wants and capacities (*Kāshṭ-hasb-maqḍūr*), either because the village was a foundation in abundant waste, and the quantity taken by each was of no concern; or because the village was really the old *raiyaṭwāri* where no co-sharing class happened to have grown up, and which is only a "joint village" under our own revenue system.

It is time to make an earnest appeal for better statistics. In each of the Northern Provinces (where these joint-villages are the salient feature) there are plenty of able officers who could gradually make out proper returns according to the real facts of constitution: there might be a doubtful class of villages perhaps—where the evidence was vague, as to whether a scheme of shares (and if so, of what nature) had ever existed; but even such a "doubtful column" as this would be instructive.

If a census were gradually taken, the bare figures would be of the highest value; but surely also they could not fail to be accompanied by explanatory comments. And we might have notes on the tenures, taking the same place as Mr. Ibbetson's invaluable notes on the Panjāb tribes took, in relation to the popular census of 1881.

The result would be perhaps a rude *bouleversement* of our current conventional ideas about "Village Communities;" but it would enable a new departure to be made, and throw floods of light on the real application of those theories of ownership and the history of institutions which, during the last twenty years, have aroused so much interested attention.

GLOSSARY OF VERNACULAR WORDS USED IN THE PAPER.

1. *Zamindār*: primarily any "holder of land"; a great landlord; a manager of a village (Oudh). *Zamindāri* alludes to a village tenure when there is one landlord. (*Z-mushtarka*, when there are several undivided.)

2. *Mutthā*: a parcel, a group of lands sold to (artificial) landlords, called *mutthādār* (Madras).

3. *Bhaiḍchārā*: custom (*dchār*) of the brotherhood (*bhāi*); a form of village tenure, in which the sharing goes, not by the law of inheritance (ancestral

principle of sharing), but by a peculiar method of allotment of *equal holdings*. The term has been used (later) as a technical term, to include *all* sorts of villages, which are shared in any way—which is not an *ancestral* or hereditary share system. By classifying villages in returns and statistics under this common head, a number of very different forms are confused, and their features lost sight of.

4. *Mirds*: inheritance; a right in land based on hereditary right; really or conquest, grant or usurpation (in origin).

5. *Pattī*: an *ancestral* share. *Pattī dāri*: a form of village tenure where the shares are all (more or less) according to the "family tree"; a fraction, by the law or custom of *inheritance*.

6. *Upri*: (Bombay-Dakhan) a class of tenants (said to mean tenants from another place) in certain villages, as opposed to a superior order of hereditary (*mirdsī*) landholders.

7. *Raiyaṭwāri*: tenure or management in which the individual landholder (*raiyaṭ*) is dealt with and considered; not a joint body of landlords or a middleman landlord.

8. *Lambardār*: the official headmen in a *joint* village (literally), "holder" of a "number" (*lambar*), *i.e.*, the person (or persons) on the collector's list who is (or are) responsible for the revenue payment in the first instance.

9. *Pāṭel* (West, South, and Central India): the village headman in a *raiyaṭwāri*, or non-joint village, called *mandal* in Bengal, and by many other local names.

10. *Panchāyat* (from *pānch* = five): a council, or managing body of elders.

11. *Kāshṭ-hasb-maqḍūr*: cultivation according to ability.

12. *Rājā*: a king, or head chief in a tribal State.

DISCUSSION.

Mr. T. H. THORNTON, C.S.I., said this paper might appear too severely professional for a London audience, but to Indian settlement officers, and to all engaged in the study of ancient institutions, it was a mine of information. One of the most interesting facts that Mr. Baden-Powell sought to establish was that in many parts of India (excepting the Panjāb) villages were originally *raiyaṭwāri*, that is to say, consisted of groups of holdings held in severalty; and that the bodies of proprietary co-sharers—which form such an interesting feature of the village communities of Upper India—were after-growths, the result of conquest, usurpation, grant from ruling powers, or the decay or decadence of chiefships. He could not give any opinion as to the accuracy of a statement which applied to the whole of India, being only acquainted personally with the land tenures of the Panjāb; with respect to these, however, he could confirm the statement in the paper, that the theory of pre-existing *raiyaṭwāri*

* Usually some conventional area, more or less corresponding to what a plough with one pair of bullocks really can, on an average, plough up.

holdings did not apply to them. Mr. Baden-Powell's view, however, had this point in its favour, that it closely resembled one of the extant theories regarding the development of the English manor. Whether it would be eventually established he could not say, but, looking to the various theories put forward by Sir H. Maine, Mr. Seebohm, Sir F. Pollock, and others, he feared there was no immediate prospect of finality in this matter. Nevertheless, Mr. Baden-Powell's conclusions, like everything he produced, were the result of the most careful and conscientious study, and would form an admirable basis for further investigation, and everyone would look forward with great interest to his forthcoming book on the land tenures of India. It was said that the *murisi* tenure was not known in the Panjáb, but the word *warisi* was, he believed, applied to holdings in the Hazarah district. He entirely agreed that the so-called tenure statements published by the Government of India were unsatisfactory, and was glad to hear that Mr. Baden-Powell intended preparing a model form, which he hoped would be considered by the authorities.

Mr. C. L. TUPPER, B.C.S., said he had been favoured with a proof of this paper, and was about to express a slight difference of opinion on what seemed to him a fundamental point, but he must confine himself to the one province with which he was acquainted (Panjáb), and as to which he took a different view as to the value of the statistics.

Mr. THORNTON said he only referred to the general statistical returns of the Government of India, not to those for the particular provinces, which were very satisfactory, as regards the Panjáb at all events.

Mr. BADEN-POWELL said his remarks were limited in the same way.

Mr. TUPPER said that would shorten his observations. All would agree that they should have better statistics if possible, and he hoped Mr. Baden-Powell would be able to put forward some specific proposal. He thought the first step should be to appoint a special duty officer to take up the matter, which, though it might appear dry, was of vital consequence to a true theory of human progress, and the Government might, therefore, well be asked to spend money on it. An officer should be deputed to go round the country, and in consultation with the local officers examine the village records and produce a comprehensive work, on the basis of which the classification Mr. Baden-Powell desired might be founded. He did not anticipate that such an inquiry would result in such a complete upset of current ideas as Mr. Baden-Powell seemed to expect. Good service had been done to the cause of inquiry into the early history of property by drawing attention to the *raiyatwári* village, the two best studies of which were the reports of Sir James Lyl

and Mr. Benett. In both these reports the same theory was put forward to explain the difference between the *raiyatwári* village and the ordinary village of the plains, and that was that in the *raiyatwári* village protection was afforded by the raja of the principality. It had long ago been said that in the Panjab the village community owed much of its strength to anarchy and private war; and where you got the protection of the raja of a small State, there you had the *raiyatwári* village growing, because that superseded the necessity for the aggregation on which the stronger form of village community mainly depended. In both cases, that is, that of Gonda and Kangra, you had the perfect form of Hindu ráj, and the Hindu law was connected with the Hindu principality. He had read the "Institutes of Manu" lately in another connection, and his own impression coincided with Mr. Baden-Powell's, that the fundamental idea of property in those institutes was not that of a joint village community. He might go farther and say, as regards Hindu law generally, with its rules as to adoption and associated and disassociated brethren, that the whole law had regard to a state of society in which property was held jointly indeed within the family, but family with family, in severalty. There were not merely two opportunities of studying the phenomena of joint-villages in the Panjáb, but three. There was the Panjáb frontier, the settled country of the Jats, Rajputs, and Gújars; and there was a strip north of Rajputana in which there were many villages not more than sixty years old. As to the facts which had led up to the joint-village, he should put the statement in a somewhat different form. There was first, tribal occupation; second, tribal conquest, third, colonisation; fourth, grants or leases by the ruler of the day; fifth, the rise or fall of particular families. On the first two heads, there was a substantial difference of opinion between him and Mr. Baden-Powell; by tribal occupation, he meant the case where a tribe either went into an utterly uninhabited country, or so completely subjugated the previous occupants that no proprietary rights remained to them. By tribal conquest, he meant the case where a tribe was superimposed on a previously existing society which still, however, retained certain rights in the soil. Tribal conquest did not always issue in the formation of village communities. In the Panjáb hills you had one form, in which the chief or raja was also the lord of the manor, and the manor was co-extensive with the area occupied by the State. In Rajasthan the Raja was also the head of a tribe, and the overlordship of the country was divided up amongst the brethren or members of the royal house. Finally, you had what had been described, the shared villages in Gujerat. Rajput India, therefore, as showing these different results of Rajput tribal conquest, was an excellent field for study of that part of the subject. Mr. Baden-Powell seemed to express some doubt as to

the existence of tribal ownership of large tracts. Perhaps what he called a tribe he (Mr. Tupper) should call a clan; but anyhow he could point to distinct evidence of tribal or clan occupation and proprietary right over extensive tracts of country. He would call attention to the vast tract of country between the Gulf of Cambay to the south, and Kulu and Lahoul to the north, and from Baháwalpur on the west, to Rewa on the east. That was Rajput India. The west was divided from the east by a great area of Mahratta conquest, and the extreme northern portion had been cut off from the centre and south. There was Yusafzai in Peshawar, the Marwats in Bannu, and the Kundis and Gandapurs in Dera Ismail Khan. The Gandapurs were the best instance. Some of them, at the last settlement, still held the whole tribal territory divided in 36,000 shares. It had often been said that these village communities were little republics. In connection with villages of one type only, that derived from tribal occupation in the plains, he would rather say that the village is a miniature tribe. The village has its *pattis* and *tarafs*, its sections, just as the tribe has its clans. The village has its village council, the *panchayat*, just as the tribe has its tribal council, the *jirga*. And just as we have the democratic Pathans and the Biloches, with their Tumandárs or tribal chiefs, so there was one type of village of a democratic character, and another where a head-man had been evolved. Perhaps the most valuable remark in the whole paper was that wherever you found a joint-village this resulted from the archaic principle of joint succession; the succession of the nearest agnates, equally and at once. He would add to that, that it might be co-extensive with different sections of society, according to the stage of progress attained; it might be co-extensive with the tribe, the clan, the village, the undivided family, the divided family. His belief was that the ever lessening diameter of the circle within which that principle applied was an index of legal progress from the joint holding of the tribe, until it reached the extreme form of severalty, the separate property of married women.

MR. G. L. GOMME said his study of Indian village communities had been only a partial one, having reference to its influence on the development of the same institutions in Europe; but in the course of his researches he had had occasion to use the Settlement Reports and other statistical information which the Government of India published, and wished to bear testimony to the valuable nature of those statistics. At the same time there were many reasons why these statistics should be put on a more scientific basis, and he would suggest that if attention were paid to ethnological and other considerations, which entered into the history of the village community, matters of great importance would be brought out which were not easily understood at present. When the village community, as a historical institution, was first introduced to Europe by Sir Henry Maine and others, there was

hardly any conception that there were any relics of it left in this country. The first idea was that the parallel between the Indian village community and the English was simply that between two institutions of one race, and it was in that room first of all, from a paper by Mr. Hewitt, that he (the speaker) had his attention drawn to the important fact that the Indian village community was not an ethnological unit, but composed of different races, each contributing its share to the building-up of the composite institution. He had ventured to apply that principle to the English evidence, and from this point of view he thought improved statistics would be very valuable. A great deal of stress appeared to be laid in the paper on the economical influences at work, but he doubted whether they were so important after all as what might be called the traditional or racial influences. There were also what might be called artificial influences of great importance, viz., those arising out of the revenue regulations; and in studying the village communities of Wales he could not help feeling that it was the revenue system introduced by the Romans which gave rise to the artificial elements found there. He was strongly in accord with the opinion expressed in the paper as to the importance of the tribe in its influences on settlements; the same kind of evidence was to be found in Scotland—there was the tribe at the top, the children of the deceased ancestor holding in groups, and the village at the bottom, holding under the system called cottar tenancy, which has been so much discussed of late; and the only possible explanation of these differences in one community was that given by Mr. Tupper, particularly in his very valuable customary law of the Panjáb, and which was now confirmed in some respects by Mr. Baden-Powell. They wanted not only statistics but information arranged statistically on ethnographic and other points, which would explain and illustrate the Indian village community, so that information thus obtained might be applied to the institutions of Europe, where all racial differences were now gone, and where it was only by the application of such a key that one could at all understand the origin of institutions.

MR. W. S. SETON-KARR said it was apparent that Mr. Baden-Powell did not command the entire accord of all his auditors on every point, and he was quite prepared to hear that some of the older civilians who had been engaged in the village Settlement of the school of Lord Lawrence did not absolutely accept all his deductions. He could not offer any detailed criticism on the whole paper, and should confine himself to those points on which he had personal knowledge; for instance, Mr. Baden-Powell said he failed to find any trace of the village communities in Bengal, and there he entirely agreed with him, though there might be traces in Béhar. In Bengal, however, you did find certain castes living in villages by themselves, and in one quarter you might find fishermen, in another Brahmans, in another Muhammedans, and you might find in Central and Lower

Bengal, where the people were almost exclusively Muhammedan, a village consisting mainly of Hindus. But in all this there was no trace of joint occupancy or proprietary right. Probably, the castes kept together for the purpose of mutual protection. He also agreed with him with regard to Manu, whose Institutes he had read in the original, and, so far as his memory served him, it was entirely correct to say that Manu's idea of property was that the land belonged to the man who cleared the jungle and tilled the soil. There were such things as villages of 10 or 100, all subject to the Raja of the day, but no trace of joint occupancy. It was with some slight astonishment he heard the statistics of the Indian Government depreciated, and he trusted that it was not intended to throw any doubt on the summary or regular Settlements which had occupied so many generations of extremely able men. Though he had never carried out a village Settlement himself, he had studied a good many; and his recollection was that the statistics acquired by the officers of the school of Robert Bird and James Thomason, Lawrence and Montgomery, were extremely detailed, and, generally speaking, extremely accurate. Mr. Thomason governed the North-West Provinces for ten years, and during the whole time was considered amongst the foremost of Indian administrators. He was particularly anxious to maintain unimpaired the village community, and to guard it against the intrusion of new men who bought up the old acres, and he looked with some misgiving on the processes of civil courts, which were sometimes employed to oust shareholders. No doubt it was a very difficult task to keep the village communities intact; and when the mutiny broke out and things were reduced to chaos, many of these new purchasers were immediately ejected, and the former owners came in again. He did not suppose that Mr. Baden-Powell intended to say that village communities ought not to have been constituted and protected, when he said that the existence of many of them was due to our own Settlement officers. As far as he remembered, what Mr. Thomason did was to fence in, protect, and guard this mode of collecting the land revenue, which was familiar and acceptable to the people of the North-West Provinces, and in great contrast to the Bengal system, where the great Zamindars were established, without the rights of the people having been ascertained. He would also bear testimony to the extreme accuracy and care with which the Settlement in the North-West Provinces and the Panjáb had been carried out, and would venture to say that the officers who were camped out for months under the village trees or on the banks of some fine stream, had exhibited a minuteness of inquiry, a depth of research, and a desire to do justice to the claims of all classes which, if equalled, had never been surpassed by any officers in India and which would not have been found even in the best officers of Akbar, the great monarch, or Shere Shah, the Afghan Intruder.

Mr. A. ROGERS desired to state a few facts with regard to the Bombay Presidency. Mr. Baden-Powell's main idea seemed to be that village communities originated in the settlement and founding of them by individual *ryots*—that is, that it was *raiayatwari*—and that the system under which villages were managed as wholes, under headmen or coparcenary bodies, gradually arose afterwards. From what he had seen in Bombay, however, he thought the opposite was the case there; and there was no instance in which it could not be found, if the inquiry were taken far enough back, that the original settlements were made by men who led a body of settlers; and the coparcenary bodies which came into existence were the descendants of those men, who held the villages in shares, according to their customs of inheritance. Mr. Baden-Powell had misunderstood the terms *mirāsi* and *upri*, used in the Deccan: they did not mean "landlord" and "tenant," but "hereditary holder" or "proprietor," and "temporary cultivators from other villages," who had no hereditary rights. There was no doubt that all the Deccan villages had in old days been held in shares by coparcenary bodies, whose rights had been destroyed under the farming system of the Mahrattas, under which the right to levy revenue annually was sold to the highest bidder. There were still villages held by coparcenary bodies in the province of Gujerāt, which were not all, as Mr. Baden-Powell supposed, mere remnants of tenures broken up by a Rājput invasion. The Nerwaders of the Khera Collectorate were still purely *pattidāri*. The *bhagdāri* villages in Broach differed from them, in being mostly held by Mussulmans, and by strangers having been admitted into the coparcenary bodies. The *talukdāri* estates in Kattyawar were villages taken possession of by powerful Rājput chiefs, and had become subdivided among their descendants, until, in some cases, a man held only one village, or part of one. But here, too, were found the descendants of the original village proprietors, who still enjoyed one-fourth, or some other share of the revenue. On the whole, he had no doubt that in Bombay the *raiayatwari* was subsequent to the village system.

Mr. A. BRANDRETH said the question raised by this paper was really what was the origin of these village communities; did Mr. Baden-Powell only mean that they were not generally descended from one family. He had had to trace the history of a very large number, and as a general rule the village had been settled, as was the ordinary custom in the world, by a certain number of persons together; one person did not go by himself and found a village, but they were generally a party. They were often settled by men of one family, who took their servants and divided the land according to their shares, but still they were village communities, whether they were a party of strangers or of brothers, if they all agreed to work the land together and share the produce in common. It was the condition of an

Oriental country and Oriental despotism which induced the formation of these village communities in self-defence. In some villages there were a great many tribes represented, and in some they were all of one family. The great object to all Indians was to keep out all strangers. Even in the towns the object was to keep one street entirely to one set of persons, and that was one reason why these village communities so much presented the pattern of a village belonging to one family. India was a country the size of the greater part of Europe, and to ask what was the origin of a system which prevailed through a country like that was almost like asking what was the foundation of a village in Europe. In Mecklenburg there would be a village with a *Hauptmann* or *Amptmann*, and all those societies like the headmen in India. In Hungary, where the big men had taken possession of the country, and ruled as they chose, a different system prevailed, and so it was in India. In India, where there had been little interference, the old families had kept their little villages in the hills divided according to their shares and customs. In the plains, where the army had swept over the country, they had got mixed up. India had never been a blank desert; it was well cultivated 2,000 years ago; and, although famine had swept over it, it had never been an uninhabited country, in which people could go and settle down and take possession of a village whenever they liked. Even in Africa, Stanley found people in every part of the continent; and so it was in India. West of Lahore, there was the old fort where "Alexander was wounded by Kattis," and Kattis still lived there. There was no reason to suppose that India had been settled by the Arian invasion in a series of village communities. No doubt they had conquered the country, as the Romans did the Britons, but the old inhabitants remained, and still kept up their customs. One must recollect, also, the extraordinary objection which prevailed in India to one having a larger share than another. One could not take up any revenue case without seeing the extreme objection there was to one brother having a larger share than another. He had known cases of a man coming back to the Panjáb, after having travelled all over India for many years, and claiming a share of the profits of a business. There was an intense feeling in India that everything must be equal, and we had no conception of the strength of this feeling in Europe, where, owing to the feudal system, there was not that intense feeling of equality. It was only in modern times that France had commenced the feeling for equal division, which was now slowly making its way in Germany. He, therefore, thought Mr. Baden-Powell's generalisations were rather dangerous. Such a large continent might be supposed to have many different systems. In conclusion, if he might make a technical correction, he would also remark that when he was in India the word *raiyatwari* only meant the way in which the Government collected the revenue from

particular villagers, or zamindars, or ryots. As for *pattidari* and *bhaiachara*, those words were applied in a technical way. He had known a case in which the question before the Court was is the village *pattidari* or *bhaiachara*; it was held in four shares by four sons, the descendants of one ancestor, who held exactly according to their shares as nearly as possible, but owing to the destruction of part of the village from a flood the shares had become unequal, and one side said it was *pattidari*, and they were entitled to re-adjust, and the other side protested that it had become *bhaiachara*, and held according to custom. The question of whether it was *pattidari* or *bhaiachara* had nothing to do with the particular family, but was merely a technical term, and though in conversations with persons who had not studied the subject sufficiently a modified meaning was sometimes attributed to it, that was the technical meaning of the expression.

Mr. MARTIN WOOD regretted that only one gentleman (Mr. Rogers) representing the Bombay side of India had taken part in the discussion, for he thought that if more information had been forthcoming about that province it would have somewhat modified the general conclusions Mr. Baden-Powell had expressed. For instance, it was stated in the paper that the village system did not obtain on the western coast, which he ventured to think was a mistake.

Mr. BADEN-POWELL said he expressly excluded the western coast from consideration. It was too peculiar.

Mr. MARTIN WOOD said four or five Panjábese had expressed opinions more or less differently amongst themselves; and he thought the term "joint occupation" required some definition. Mr. Baden-Powell seemed to speak of it as indicating a sharing of all the produce; but the term was applicable in many respects to what he described as the *raiyatwari* village, where the people were united for common purposes, although not necessarily distributing the produce in common. It might apply to any case where some body of village servants were recognised as entitled to customary maintenance. It was hoped that village councils might be utilised or restored for the purposes of modern administration.

Dr. CHARLES DRYSDALE said it appeared to him that, in such a very large continent as Hindostan, containing at present 285,000,000 of inhabitants, with a large number of races, it was impossible that any one particular system of village holding could be described as the usual one. So many different races had come to Hindostan, not to speak of Rájputs and the inhabitants of Bokhara, Samarcand, Persians and others, that it could not be expected that Sir Henry Maine's descriptions of village communities could be generally accepted. At one time he thought

that was the case, not having read many works on the subject, but further investigation showed how fallacious that must be, and he thought Mr. Baden-Powell had done a great deal of service by showing that all kinds of holding took place in Hindostan as well as in Europe.

THE CHAIRMAN, after expressing his regret that Lord Reay had been unable to preside, said his own experience of village communities in India was very small, but nevertheless he could appreciate the light thrown upon the question by this very interesting paper. The subject was one of extreme complication, as shown not only by the great diversity of opinion now expressed, but by the fact that a great portion of the paper had been devoted to clearing up misunderstandings between the two main types of village communities, which were called (a) *raiayatwari*, (b) the joint type; and also that in endeavouring to explain how these types were broken up, and one superimposed on another. Mr. Baden-Powell had been forced to have recourse to a most exhaustive classification, and even then there would be overlapping distinctions, which made it very difficult so say under what head the village would come. In Bengal, with which he was acquainted, there was no opportunity of studying the types of village communities to which officers in Northern and Western India were accustomed. Nevertheless, in Béhar he had come across distinct traces of Rājput families holding villages in what must certainly have been a joint type, all of the same stock as the chief landlord, through whom they now paid their revenue. There was possibly another type at the extreme opposite end of India—Silet and Kachar. In Silet the revenue was settled for want of large zamindars, almost with the cultivators—small bodies of Mohammedan cultivators,—the representatives apparently of military colonists, who had been placed to guard the frontier. The peculiarity of those communities was that, unlike the general practice in Bengal, which was, when a man became rich, to sub-infeudate, to give a lease and a sub-lease, the tendency was to bring in fresh members of the village ownership. To extend laterally instead of perpendicularly. In Kachar there was, again, a different type; the revenue being settled there with joint stock companies, men bound by no tribal bond, nor even of one religion, but consisting of Kacharis and Hindus, of Mohammedans and Manipuris, all in one joint stock company, taking up land for a village, settling the division amongst themselves, and agreeing with the Government for its revenue. That system descended from the old Kachar-Raj. It worked simply, and had been adopted by immigrants from Silet, who now formed the bulk of the cultivators and were mostly Mohammedan. He regretted that Mr. Baden-Powell had had to cut short what he had written about the Dravidian type of village in India. That had recently come under the observation of the Government of Bengal in rather an unpleasant way. The type was

a very interesting one. You had the original clearers of the jungle—the *bluinbars*—who divided the produce amongst them, with the *rajhus*, or king's share, and the *mahito*, king's accountant, all of these ancient institutions having their special rights and incidents; but superimposed on this system we find the joint landlord system of another race—mostly Rājpoos, immigrants from the North and West, and representing, undoubtedly, the grantees from the Rajah. The Ooraon and Kol races were exceedingly tenacious of their rights, and the traditions of their old holdings, and the problem of reconciling the claims of the grantees, with traditional pre-existing rights of the older system, was exceedingly difficult, and had, on more than one occasion, led to serious troubles. Last year these Kols and Ooraons found they could get some help in their struggles from some of the Catholic missionaries, and the result was that they became, nominally, Christians, not by tens or hundreds, but by thousands, and this had added very much to the bitterness of the conflict, and the difficulty of reconciling the competing claims. But the type of village was precisely that which Mr. Baden-Powell had explained, a Dravidian village with an alien grantees superimposed upon it, and as he had explained, it was one which gave trouble, and might lead to serious difficulty. With regard to the demand made by Mr. Baden-Powell, and other speakers, for better statistics, he did not at first clearly understand what was suggested, but he gathered, from the discussion which had taken place, that it was not that there was any error or deficiency in the "record of rights" prepared at the settlements of these Northern Provinces, for those records they in Bengal had always looked upon with envy and admiration, but the deficiency really was in the classification of these records, and the way in which the information collected was brought before the public. That being so, the suggestion that the matter should be brought before the Government was a reasonable one; but he confessed he should have been inclined to deprecate anything which would lead to an increase of work being thrown on the already over-taxed district officer and his subordinates. He concluded by proposing a vote of thanks to Mr. Baden-Powell.

The vote of thanks having been carried,

MR. BADEN-POWELL, in acknowledging the kind reception accorded to his paper, begged leave to deprecate the idea that he had set forth any general theory of origin for villages. He had only stated certain facts which he believed would stand the test of inquiry. He had carefully distinguished the different parts of India, and hoped that he had guarded against any general treatment of India as if it were one. So far from advancing any general theory, it was his express object to point out that there was, apparently, in the public mind, a theory, which was that all villages were of one class—all, *i.e.*, held jointly—in common ownership, and that this form was the earliest, and only advanced to the individual form at

a later stage. This was certainly not the case, at least as a general rule. Facts showed, he submitted, conclusively, that there were two types of village, and that the one which he called *raiayatwari*—a term merely used for convenience to signify the absence of a joint body of co-sharers—was not a later stage of the other type, but was the early Dravidian form. With reference to what Mr. Rogers said about Bombay, he gave no reason or authority, except assuming that Mr. Baden-Powell had less experience of Bombay. It was submitted, in reply, that Mr. Powell had carefully studied Bombay, and he is confident that his position is a true one, and that it would be found that the villages—which were not at all universal—in the Dakhan, where an hereditary class existed as well as the “Upri,” a transitory tenant class would be found not to be the earliest form; the Dravidian individual holdings had preceded it, and it was a relic of an early Maráthi dominion, which passed away before the final great development of Maráthi rule under Sivaji in the 17th century. The evidence was fully gone into by the late Colonel Sykes, in his paper in the “Journal of the (London) Royal Asiatic Society.” As regards statistics, he of course did not refer to the Settlement Records; it was just because they were so good, and contained such ample materials, that he depreciated the Secretary of State’s Blue-book of “Agricultural and Tenure Statistics,” which alone were accessible to general readers and students in England. It was these alone he objected to. The figures shown for villages (in Form E) for the North-West Provinces, Oudh, and the Panjáb, were every one of them absolute rubbish. He had expressly avoided attempting to give any proper form for statistical tables. The time had not come for them, it would require consultation and consideration in order to devise a simple classification, that would show the essential differences of village-form and constitution, and not burden the officials with a troublesome task, that would be regarded as impossible to impose on them. It was very little consequence which the term *bhaidchári* in itself meant or ought to mean, but the fact remains that by lumping together a large number of villages under this one designation, a whole series of really wide and important differences were lost sight of. It would be as easy to compile right tables as wrong ones, and if instead of the old distinction, a new set of simple classes, really going to the root of the several principles of union or constitution, were discovered, the tables published would be of immense value. Mr. Tupper briefly referred to special statistics of tenures existing in the provinces, which were quite distinct from those which alone Mr. Baden-Powell alluded to, and he was sure Mr. Tupper would fully agree with him as to the Blue-book statistics.

MR. HYDE CLARKE writes:—Not wishing to protract the discussion at a late hour, I beg to submit the accompanying observations. The subject, which

has been so well presented to the Section by Mr. Hewitt and Mr. Baden-Powell, is of practical importance. It concerns us greatly, in regard to the government of India, to know what are the institutions of the people, what have long prevailed, and what are suited to their circumstances. The village organisation is one branch of this subject, and it is as essential for us to know its real incidence as to devise inventions of our own, which are not necessarily the outcome of superior civilisation, but in many instances the result of casual circumstances in this country. Mr. Powell particularly offers a suggestion for the adoption of the Section, that application should be made to the Secretary of State for the collection of information on the details of the subject. This appears to me well deserving of support. While I held the chairmanship of the Section, propositions of this sort were considered by the Sectional Committee, and if approved, forwarded to the Council for the action of the Society. In this way some useful representations were successfully made. After Sir H. Maine had published his researches on village communities, it flashed as a revelation that there were such institutions, which were well known to our Indian officials and all scholars who possessed the usual amount of knowledge as to the condition of Hindostan. People have been very much surprised to find there are corresponding examples in Europe and even in this country. Mr. Hewitt threw a light on the causes of this by illustrating the Kolarian and Dravidian instances, and as a matter of universal and comparative history their epochs represent comparative epochs in European history. Mr. Powell furnishes a great variety of results showing the various developments of the system. Although we have now very much information we want more, for speculation has run wild, and this to an extent which influences our theories of politics and jurisprudence. When it is attempted to assign village communities to tribal occupation, the question becomes what tribal occupation, whether of one tribe, or, as in ancient Europe, and now among the Nagas, of members of several tribes, acting in common confederation. The whole subject of proprietary rights in land has yet to be investigated. A recent paper of my own, at the Anthropological Institute, shows throughout the world a widely distributed institution of separate proprietorship of trees in land owned by others. Sir Henry Maine appears to have had in his mind that proprietorship in land might be due to discovery, but he had not before him the specific facts.

APPLIED ART SECTION.

Tuesday evening, April 14th, T. ARMSTRONG in the chair. The paper read was “Decorative Plaster Work: Modelled Stucco Work,” by J. T. ROBINSON, F.S.A.

The report of the paper and discussion will

be printed in next week's number of the *Journal*.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 15, 1891; Professor CLEMENT LE NEVE FOSTER, D.Sc., in the chair.

The following candidates were proposed for election as members of the Society :—

Dowsing, Herbert John, The Cedars, Manor-park, Essex.

Gostling, David, 1, Dalal-street, Fort, Bombay.

Grey, Commander Robert, Eastern Telegraph Company's Cable Ship "Amber," Malta.

Klein, Rev. Leopold Edmund Baynard, D.Sc., F.L.S., 11, Horbury-crescent, Notting-hill-gate, W.

Moloney, His Excellency Captain Sir Cornelius Alfred, K.C.M.G., Lamarsh-house, Richmond-hill, Surrey, and British Honduras.

Tweedale, John, F.R.I.B.A., 12, South-parade, Leeds.

The following candidates were balloted for, and duly elected members of the Society :—

Gregory, William John, 1, St. John's-terrace, Weymouth.

Jenkin, Charles Frewen, Waltham Abbey, Essex.

McMullen, James F., South-mall, Cork.

Orr, Cecil, 20, Park-road, Harlesden, N.W.

Owen, Edward Humphrey, J.P., F.S.A., Ty Coch, near Carnarvon.

Peach, Charles Stanley, 8, John-street, Adelphi, W.C.

Pocklington, Frederick A., Oldham-place, Renshaw-street, Liverpool.

Sully, Herbert Thomas, Oriel-house, Springfield, Chelmsford.

Thomas, William Luson, 190, Strand, W.C.

Wain, William James Carruthers, 25, College-hill, E.C.

The paper read was—

THE SOURCES OF PETROLEUM AND NATURAL GAS.*

By W. TOPLEY, F.R.S.

Geological Survey of England.

In the following paper it is proposed to take a general survey of the geological conditions

* The literature of petroleum is now very extensive, and many of the districts here referred to have been repeatedly described. I have therefore not attempted to give references, save in a few cases. Mr. Boverton Redwood's Cantor Lectures, 1886 (vol. xxxiv. of this *Journal*) should be referred to as giving a general description of the petroleum-

under which petroleum and natural gas occur in various parts of the world; and to give some conclusions, of no little interest and of much importance, to which geologists of the United States have been led as regards the vast areas with which they deal. This being the special object of the paper, I shall have little to say respecting many points generally discussed in publications on this subject. The ground proposed for our survey is sufficiently extensive as it is.

ORIGIN OF PETROLEUM.

Many theories have been advanced as to the origin of petroleum. These but slightly interest us on this occasion, save in so far as they bear on the different conditions under which petroleum occurs in different districts, and on the prospects of future supply. Prof. Mendelejeff and many Russian chemists—and similar views have been advocated in France by Berthollet and others, and in this country by Mr. W. Anderson—believe that petroleum has a purely chemical origin, having been generated by the downward passage of surface water into regions of the earth's crust where metallic iron, in combination with carbon, exists in a highly heated state; or by water containing carbonic acid being carried down to regions where potassium and sodium exist in a metallic state.

The advocates of this theory are probably led to its adoption, by their inability to explain the origin of such great stores of petroleum as occur along the Caucasus by any other hypothesis; and also from a misapprehension as to well-ascertained facts regarding the mode of occurrence of petroleum in equal quantities over vast areas of the United States.

They perhaps assume that if petroleum has an organic origin, it has been due to the distillation or the slow destruction of only vegetable matter; further, that the great storehouse of fossil vegetable matter is in the coal-measures, whereas the great reservoirs of petroleum and gas are (in America) chiefly in the rocks which underlie the coal; and yet again that these strata are comparatively barren of organic

bearing districts, and also much information upon the practical applications of the oil. Mr. Redwood has also described the various petroleum fields before the Society of Chemical Industry, Russia:—February 28, 1885; America, June 30, 1887; India, April 21, 1890. I have profited by some criticisms offered by Mr. Boverton Redwood, and by information afterwards supplied by him, to improve and augment parts of this paper, giving later statistics than were at my command. These alterations are chiefly in the descriptions of the Caucasus and Galicia; but some information is also added elsewhere.

remains. But many limestones and shales of the Devonian and Silurian rocks of America are literally crowded with fossils, some of the limestones being almost entirely composed of them.

The American geologists and chemists are agreed that petroleum has resulted from the decomposition of the fossils in the shales and limestones of the Silurian, Devonian, and Lower Carboniferous rocks, chiefly the remains of animals, but in some cases also the remains of plants; that the gas and petroleum thus formed are stored in porous sandstones and limestones, and are prevented from escaping by a covering of impervious shale.

That the organic theory of the origin of petroleum best explains the facts over the greater part of North America is beyond question. It probably also serves best for most areas. But since chemists have shown that the inorganic theory is a possible one, it may perhaps explain the facts for some other regions.

As regards the future supply of petroleum, the question of its origin is one of importance. If it has resulted from the decomposition of animal or vegetable remains, the supply, however vast and seemingly inexhaustible at present, must needs be limited, and each area will in time be drained. If, however, petroleum be due to chemical action in the interior of the earth, the supply may be practically inexhaustible in the districts where it is thus formed. Baku may thus sustain its reputation long after every petroleum field in the United States has run dry. The fact that, even at Baku, the supply is said to be decreasing, is no argument against the inorganic theory, as it is quite possible that the petroleum, however originally formed, may have been stored to a vast extent in porous beds. When these storage reservoirs are drained, we shall depend upon the steady supply from the earth's internal laboratory; but when the storage reservoirs which have been filled from the decay of animal and vegetable organisms are exhausted, there is no further supply to come, or, rather, the supply from the continuous decay of such organisms would be so insignificant as to be left out of account altogether. The great pressure of the gas and petroleum in many wells has been held to afford evidence of a deep-seated origin; but, as we shall presently see, this pressure necessarily results from the known geological structure of the country in many parts of the United States. Again, the fact of petroleum and gas often

occurring along the flanks of mountain chains, has been taken as evidence of its deep-seated and inorganic origin; but the more important gas and petroleum fields of North America lie in areas far away from mountain chains, and where the rocks have been only gently folded.

MODE OF OCCURRENCE.

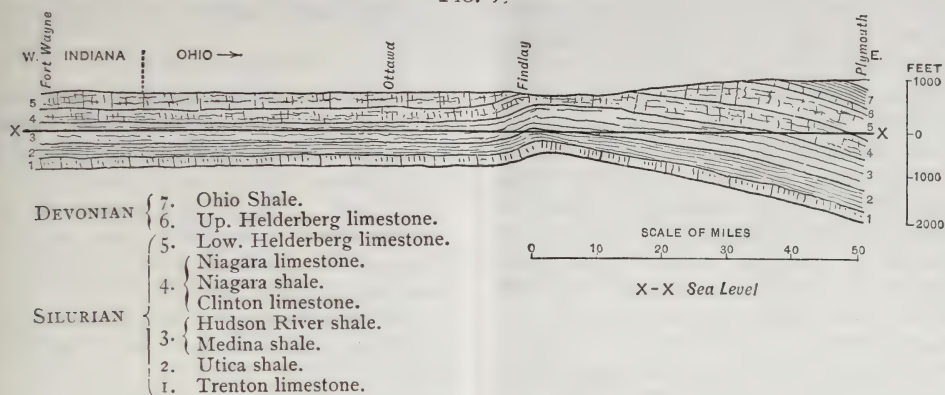
Leaving now the question of the possible origin of natural gas and petroleum, we will see under what geological conditions they occur in some typical cases.

The general rule in Pennsylvania, New York, Ohio, Indiana, and Canada, is that that they are stored in porous sandstones or limestones, where the rocks have been gently folded into anticlinal ridges; or where, if there is a small and general dip of the strata, the dip is for a space interrupted, forming a shelf of more nearly horizontal rock, after which the strata resume their normal gentle dip.

If we trace out the underground range of these petroleum-bearing beds beyond the areas in which they are now productive, we find that they rise towards the surface, and often actually crop out there, but the gas and petroleum which they may there once have contained has long since been lost. Like other porous rocks in such areas, they now contain water. It is the pressure of the water from the outcrop and the higher areas of the porous rock, acting along and down the dip, which accounts for the pressure of the gas and petroleum within the productive areas. When the porous bed containing gas or petroleum is tapped by a borehole, the contents are forced up by the pressure of the water from the outcrop, and the pressure depends upon the relation between the level of the outcrop and the point at which the porous bed is tapped. In fact, the condition of things somewhat resembles that so well known in the case of artesian wells.

"Every richly-productive gas-field, at least in the Eastern States and Canada, is a dome or inverted trough formed by flexure of the rocky strata; and in every such dome or inverted trough there is a porous stratum (sandstone in Pennsylvania, and coarse-grained magnesian sandstone in Ohio and Indiana) overlain by impervious shales. These domes or arches vary in dimensions, from a few square miles in some of the Pennsylvanian areas, to 2,600 square miles in the great Indiana field. Within each gas-charged dome there are found three or more substances arranged in the order of their weight; gas at the top, naphtha (if it exists in the field) and petroleum

FIG. 1.



SECTION THROUGH FINDLAY, OHIO (ORTON).

below, and finally water, which is generally salt, and sometimes a strong and peculiar bittern. This order is invariable throughout each field, whatever its area, although in Indiana, at least, the oils are found most abundantly about the springing of each arch, while towards its crown gas immediately overlies brine; and the absolute altitude of the summit-level of each substance is generally uniform whatever the depth beneath the surface. Since the volume of gas or oil accumulated in any field evidently depends on the area and height of the dome in which it is confined, and upon the porosity and thickness of rock in which it is contained, the productiveness of a given find may be definitely predicted after the structure and texture of the rocks have been ascertained.

"In all productive bitumen fields the gas and oil are confined under greater or less pressure. When a gas well is closed, it is commonly found that the pressure at the well head gradually increases, through a period varying from a few seconds in the largest wells to several minutes or even hours in wells of feeble flow; and that afterwards the pressure-gauge becomes stationary. This is the 'confined pressure,' 'closed pressure,' or 'rock pressure' of the prospector; or, more properly, the 'static pressure.' When a well is open, and the gas escapes freely into the air, it is found that if the stem of a mercurial or steam gauge is introduced, a certain constant pressure is indicated. This is the 'open pressure' or 'flow pressure' of the gas expert, and the capacity of the well may be determined from it. The static pressure varies in different fields. In Indiana it ranges from 300 to 350 pounds per square inch, in the Findlay field it is from 450 to 500 pounds, and in the Pennsylvania field it varies from 500 to 900 pounds.

"The cause of this enormous pressure is readily seen in Indiana. The Cincinnati Arch (in which the gas of the great Indiana field is accumulated) is substantially a dome, about fifty miles across, rising in the center of a stratigraphic basin fully 500 miles in average diameter. Throughout this immense basin

the waters falling on the surface are in part absorbed into the rocks, and conveyed towards its center, where a strong artesian flow of water would prevail were the difference in altitude greater; and the light hydrocarbons floating upon the surface of this ground water are driven into the dome, and there subjected to hydrostatic pressure, equal to the weight of a column of water whose height is the difference in altitude between the water surface within the dome and the land surface of the catchment area about the rim of the enclosing basin. Accordingly, the static pressure is independent of the absolute altitude of the gas rock and of its depth beneath the surface, except in so far as these are involved in the relative altitudes of the gas rock and a catchment area perhaps scores or even hundreds of miles distant. Gas pressure and oil pressure may, therefore, be estimated in any given case as readily and reliably as artesian water pressure; but while the water pressure is measured approximately by the difference in altitude between the catchment area and well head, that of gas is measured approximately by the difference in altitude between catchment area and gas rock, and that of oil is measured by the same difference, *minus* the weight of a column of oil equal to the depth of the well. It follows that the static pressure of gas (as indicated at the surface) is always greater than that of oil, particularly in deep wells. It follows also that the pressure, whether of gas or oil, is not only constant throughout each field, but diminishes but slightly, if at all, on the tapping of the reservoir, until the supply is exhausted; and hence that pressure is no indication of either abundance or permanence of supply." *

* This clear and concise account of the geological conditions under which gas and oil occurs in parts of the United States is taken from an article by Prof. W. J. McGee, on "The World's Supply of Fuel," in *The Forum*, for July, 1889, pp. 560-562. It is impossible here to refer to the numerous publications on the subject. Those of most value, and those which have been of great service in the preparation of this paper, are the reports of the Pennsylvanian Geological Survey, especially those by Lesley, Ashburner, and Carll; the

The early history of Canadian petroleum is of some interest to us, inasmuch as Dr. T. Sterry Hunt, who well studied the subject, was perhaps the first geologist who clearly understood the true geological history of American petroleum. He showed (1) that the oil was produced in or near to the beds in which it is found, by the decomposition of the vegetable or animal remains; (2) that the porosity of the sandstones or limestones is sufficient to account for the great stores of petroleum which they contain; (3) that petroleum and gas mainly occur along anticlinal lines.*

The comparatively simple structure of the petroleum region here described does not obtain all over the world. Often the strata in which oil occurs dip at high angles, or they may have been sharply folded and broken, the denuded edges of the petroleum-bearing bed being exposed at the surface. In such cases the yield of wells is comparatively small, there being little or no artesian pressure to force up the oil. Such regions rarely now contain much gas.

Although there is much variety of geological structure in petroleum-bearing regions, we shall find that there is frequently an anticlinal arrangement of the strata, the oil coming up along the arch.

There is no uniformity in the geological ages of the strata which yield petroleum. Even in North America the age ranges from lower silurian to tertiary; both gas and oil also occur in the drifts. Rocks of secondary age, however, with the exception of the cretaceous, are not oil-bearing in North America. In Europe, only small quantities occur in Palaeozoic rocks. In Hanover it ranges from trias to cretaceous. In Eastern Europe it is mainly tertiary, and wholly so in the Caucasus.

In other parts of the world the petroleum-bearing beds are, so far as is known, rarely of older date than upper secondary. Volcanic rocks occasionally contain petroleum, but there is good reason to believe that these cases are generally the result of impregna-

tions into porous reservoirs of volcanic rocks from neighbouring sedimentary strata.

UNITED STATES.

The petroleum of Pennsylvania was known to the Indians* before the white men entered the country, and was used by them for medicinal purposes, both as an ointment and for internal use. The Indians called the oil "Antonontons," the white men called it "Seneca Oil," after the Seneca Indians, in whose country some of the oil springs occurred. The earliest notice dates from 1627, where some oil springs near Lake Erie were visited by Daillon, a French missionary. In 1789 it is recorded that the Indians sold the oil to the white people at four guineas a quart.

There is good reason to believe the petroleum of Pennsylvania was known to races who preceded the Indians, as here and there shallow wells or holes abounded, evidently made for petroleum, the history and uses of which were unknown to the Indians. Some of these ancient pits still remain in the wilder parts of Warren County, but elsewhere they have disappeared. The early petroleum wells were very shallow, only a few feet deep, in which water and petroleum collected, and the latter, floating on the top, was taken up by blankets.

Petroleum and gas in deep wells and borings seem to have been discovered accidentally in 1814, in Ohio, when boring for salt and brine. In 1829, a rather remarkable event occurred near Burkesville, Cumberland County, in Kentucky. In boring for salt water oil was struck, which discharged many barrels at intervals of from two to five minutes. After spouting in this way for three or four weeks, the flow became constant at several thousand gallons per day. The oil flowed into the Cumberland River, and when set on fire it burned on the surface of the water for more than forty miles below the well.

Although the importance of boring for oil should have been apparent from the success of the accidental trial in Kentucky, and from others in Alleghany, it is curious that no systematic attempt to drill for oil was made till 1859, when Mr. Drake, the Superintendent of the Seneca Oil Company, put down the famous "Drake Well" at Titusville. This was not deep, only 69½ feet to an oil-bearing

Reports of the Ohio Survey, by Orton, and an admirable paper by the same author, in the 8th Ann. Rep. U.S. Geological Survey, 1889. Papers by Newberry, Peckham, and others, have also been of much service. Crew's "Practical Treatise on Petroleum," 1887, contains a great amount of valuable information on the subject. The annual reports by J. D. Weeks, in the "Mineral Resources of the United States," are of great value.

* "Amer. Journ. Sci.," ser. 2, vol. xxxii. p. 85, 1861. "Geology of Canada," pp. 379, 187; 1863.

* These notes on the early history of American petroleum are mainly taken from Mr. J. F. Carll's report on the "Oil and Gas Regions," Ann. Rep. Geol. Survey, Pennsylvania, for 1886. Mr. Carll based his statements on Mr. W. T. Buck's paper in Trans. Hist. Soc., Pennsylv., 1876.

bed; the oil rose to within 10 feet of the surface. The well produced, at first, 25 barrels a day by pumping, but afterwards the yield fell to 15 barrels. Numerous wells were drilled in the following year (1860), and in 1861 the first "flowing well" was obtained, on Oil Creek. At once many other wells were bored, some flowing at the rate of from 2,000 to 2,500 barrels per day. Wells were quickly bored in other areas, and the oil industry rapidly developed. The first pipe for the transport of oil was laid in 1865.

In accounts of the earlier explorations for petroleum, we read little of natural gas; the gas had probably escaped into the air, and it was only met with in quantity and under-pressure where deep borings were carried out. As far back, however, as 1821, natural gas was used in a small way for lighting houses at Fredonia, in Chatuaqua Co., New York. No further development of this industry seems to have taken place till 1870, when gas-engines were run by natural gas at Pine Grove, in Venango Co. In 1872, gas was discovered at Newton, and was laid on in pipes to consumers for fuel and light. Gas was used in iron-making at Leechburg in 1874.

Pennsylvania, New York, Ohio and Indiana.—The quotation given in an earlier part of this paper illustrates the general character of this important region. Its amazing productivity is well known, and statistics of the various districts are readily available.* To emphasize some points of chief geological interest is all that can here be attempted.

The geological position of the gas and oil-bearing rocks range from lower Silurian (Trenton limestone) to lower carboniferous. Until the great stores of the Trenton limestone were discovered, the Devonian and lower carboniferous strata were the most important sources.

The oil-sands of Venango Co., Pennsylvania, are often in lenticular beds, the longer axes of the beds ranging from north-east to south-west. In thickness they range from a thin band up to 100 feet. Their width may be only one or two miles, their length sometimes 20 miles. Some of the strata die out before reaching the outcrop, and consequently are known only by borings.

When two or more such beds occur in vertical succession, the lowest usually contains most oil or gas. The lenticular nature of the sand may explain how in some cases neigh-

boring wells affect each other, whilst elsewhere they may not do so.

The early borings were mainly along valleys. When explorations were carried on over high ground, the beds discovered were called "mountain sands." These lie some hundreds of feet above the true Venango sands; they occasionally contain some oil and gas. Beneath the Venango group, other gas or oil-bearing sands were subsequently discovered, the most important of which are the Warren sands of Warren Co., and the Bradford sands of McKean Co. The Berea grit is the most important source of oil in Eastern Ohio.

In all cases these productive sands are underlain and overlain by shales. The underlying shale is the source of the petroleum or gas; the sand is the porous reservoir in which they are stored; the overlying shale is an impervious cover which retains them in the reservoir.

When gas and oil are found stored in limestone, they may sometimes have been produced in the limestone itself, but the impervious cover of shale is still required to retain them. The Trenton limestone, the chief source of gas and oil in Indiana, and an important source now in Western Ohio, is the upper member of a series of limestones which have been proved to a depth of 1,800 feet. The true Trenton limestone itself is several hundred feet thick. All this thickness of limestone may have produced the hydrocarbons, although they are stored mainly in the upper part of the Trenton. But not always so; it is only when the Trenton limestone occurs in the cavernous condition that it is highly productive; this condition is due to some of the lime having been removed, its place being taken by magnesia.

The storage capacity of the porous sandstone and limestone is very great, and sufficiently accounts for the great yield of the wells. The Waterlime bed, at 500 feet in thickness, and with a capacity of only 0.1 per cent., would contain 2,500,000 barrels of oil per square mile. One hundred square miles of such rock would yield the entire production of New York and Pennsylvania up to January, 1883. But the capacity for storage is often much more than the figures taken here. Carll has shown that some rocks can contain from 1-10th to 1-8th of their bulk in oil.

As already described, the most productive areas of the Trenton limestone are mainly over anticlinal lines, in the arches of which the gas and oil are stored. Sometimes these anticlinal

* These were illustrated by diagrams, shown as lantern slides.

areas are closed at one or both ends, by the compactness and impermeability of the rock.

The anticlinal structure seems to be of more importance with gas than with oil, the gas collecting in the crest of the arch. But complete anticlinals are not always formed; often there is merely a lessening of the dip, the gas collecting on the terrace. In Eastern Ohio many of the gas and oil fields have this terrace-like structure.

Kentucky and Tennessee.—As petroleum fields, these are not of great importance. But there are some other peculiarities which render Kentucky interesting and instructive, as a source of gas, which here occurs in the Ohio shale. Elsewhere the incursion of salt water into a gas well is the sure precursor of failure, showing that the reservoir is becoming exhausted; but here salt water and high-pressure gas occur together. Some of the wells here, also, have long lives: one, at Moreman, has been producing gas and brine since 1863. Salt has been manufactured here from the brine since 1872. Professor Orton estimates that the gas from this well has had a total value of 200,000 dollars.

Colorado.—Professor Newberry describes the oil here as occurring in the middle cretaceous beds—the Colorado shales. Borings have been made to a considerable depth at Florence, near Cañon city; the deepest (in 1888) was 3,047 feet. The wells give a steady stream of oil, of from 20 to 100 barrels per day, the average being about 50 barrels. Some of the wells are said to increase in flow. There are oil springs in Western Colorado, but these have not yet been developed. The production in 1887 was 76,295 barrels, and in 1888 was 297,612.

Wyoming.—Petroleum has long been known to occur here, but it has not been largely worked. The best known district is in Carbon county, where wells to a depth of 800 feet were put down. Oil came at first under considerable pressure, but soon fell to a steady flow of from 600 to 1,000 barrels per day. The oil is of low quality, the luminants averaging only about 25 per cent. It is said that oil of a better quality, in some cases yielding 61 per cent., exists further to the north-east.

California.—Petroleum is chiefly found in the southern counties. It occurs mainly in sandstone of tertiary age. The beds are generally inclined from 30° to 85°, and, consequently, the edges outcropping. High-pressure wells are consequently rare, the oil being obtained by pumping. An exception

occurred at Adam's cañon, Ventura county, where a boring 720 feet deep met with oil, which rose 75 feet into the air, and flowed at the rate of 800 barrels per day. The yield is comparatively small, but the wells give a steady production for a longer time than most gushing wells. Some wells are now 1,000 feet deep; one is 2,330 feet; but most are less than 1,000.

There is not much natural gas in California; it occurs near Los Angeles, flowing at a low pressure. The cost of wells is stated in the official reports to be about three times what it is in Pennsylvania, partly on account of the steep inclination of the beds.

The following are some statistics of the production of petroleum in the United States* (in barrels of 42 gallons):—

	Penn- sylvania and New York.	Ohio.	West Virginia.	California.	Total.
1860...	500,000	...	...	...	500,000
1861...	2,113,609	...	...	...	2,113,609
1869...	4,215,000	...	...	...	4,215,000
1872...	6,293,194	...	...	...	6,293,194
1874...	10,926,945	...	...	...	10,926,945
1876...	8,968,905	31,763	120,000	12,000	9,132,669
1878...	15,163,462	38,179	180,000	15,227	15,396,868
1880...	26,027,631	38,940	179,000	40,552	26,286,123
1882...	30,053,500	39,761	128,000	128,636	30,349,897
1884...	23,772,209	90,081	90,000	262,000	24,214,290
1885...	20,776,041	650,000	91,000	325,000	21,842,041
1886...	25,798,000	1,782,970	102,000	377,145	28,285,115
1887...	22,356,193	5,018,015	145,000	678,572	28,249,597
1888...	16,484,668	10,010,868	119,448	690,333	27,615,929
[1889]	21,519,649]	—	—	—	—

The total production of oil in the United States up to the end of 1888 is estimated at over 373,000,000 gallons; but, in addition to this, a great quantity, estimated at from 10,000,000 to 20,000,000 gallons, has been wasted. Of the total production, Pennsylvania and New York has given 92 per cent.

CANADA.

The greater part of the Canadian petroleum hitherto produced is found in Lambton county, Ontario. It occurs along an anticlinal line, the wells being confined to a narrow belt of from 1 to 4 miles wide and about 20 miles long, running from north-east to south-west. The oil is here found in Devonian rocks.

* From the U.S. Mineral Statistics. The "total" includes small quantities from States other than those mentioned.

Oil was first pumped here about 1839. Up to 1862 there are no statistics: in that year the production was 11,775 barrels. The yield gradually rose to 575,000 barrels in 1879, it declined to 250,000 in 1883-1886, and then suddenly rose to 868,345 in 1887; in 1888 it again declined to 772,392 barrels. The average depth to the oil rock is nearly 500 feet. Several wells have been bored in Essex county. One well in Comber county obtains a small quantity of oil from the Trenton limestone. Few of these wells produce as much as 25 barrels per day; the great majority pump only about 1 barrel. In the early days of the Ontario oil industry the wells seem to have been much more productive.

An import duty of $7\frac{1}{2}$ cents per gallon is levied in Canada on American petroleum, but this is nevertheless imported to a large extent into the Dominion, and sells at a higher price than Canadian oil.

Either the general quality of Ontario petroleum has declined, or a higher standard has been required for refined oil. In 1881, the ratio of crude to refined oil was as 100 to 50; in 1887 it was as 100 to 38.

Recent explorations in North-Western Canada have shown the existence of important stores of petroleum and gas in various parts of that vast district. In Devonian rocks along the Athabasca River petroleum exists in great quantity. It has also saturated the sandy beds of the cretaceous series. It occurs along the Vermilion River, and in numerous places along the Mackenzie River. It is known on Great Manitoulin Island, from the Trenton beds. It occurs also in cretaceous rocks, near important seams of coal, at Crow's Nest Pass, in the Rocky Mountains. This is the only place yet known in British Columbia where petroleum occurs in any quantity; but bituminous matter oozes from the rocks on the Tar Islands, Queen Charlotte Islands.

In some borings for water along the Canadian Pacific Railway gas has been found; that at Langevin Station, 35 miles west of Medicine Hat, being the most important in quantity. The gas here comes from cretaceous rocks. Dr. G. Dawson suggests that the boring, 1,426 feet deep, should be continued down, to ascertain if the cretaceous rocks are underlain by Devonian, and if these latter are petroleum-bearing, as in Athabasca. He points out that probably this is on an anticlinal, and that it is the best place along the railway for an exploratory boring.

Gas issues from the Trenton limestone on the north side of the St. Lawrence, near Louisville and Three Rivers, and again at St. Leon, on the Ottawa River. It has been known from early days, and has been utilised to a small extent.

Further east, petroleum has been known in Gaspé; it occurs to a small extent in Nova Scotia, Cape Breton Island, and on the west coast of Newfoundland. In all these places, however, the quantity of gas or petroleum is comparatively small, and the future production of Canada will, doubtless, come from the North-West Territories.

MEXICO.

Petroleum occurs in Tertiary beds on the east coast, in the State of Vera Cruz, between the Panuco and Tuxtlan Rivers. The wells so far sunk are mostly near the coast. Around Lake Culco there are said to be forty oil-springs.

VENEZUELA.

Petroleum occurs along the slopes and at the base of two spurs of the Cordilleras, Lake Maracaibo lying in the basin thus formed. It has been worked near Belijoque and St. Christobal.

TRINIDAD.

The pitch lake of this island is well known. The bituminous matter comes from the "Newer Parian" formation of G. P. Wall, which he takes to be Upper Miocene.

Petroleum is recorded from Cuba and from St. Domingo.

COLUMBIA.

The existence of petroleum in some quantities has been reported at Tubara, 12 miles from Barranquilla, near the mouth of the river Magdalena.

PERU.

Petroleum occurs along the Pacific coast between Cape Blanco and the Tumbes river. It has mainly been worked near the village of Zorritos. Wells were bored, one to a depth of nearly 500 feet, which are said to have yielded oil, at first at a rate of from 600 to 1,000 barrels per day. Further attempts have recently been made to develop Peruvian petroleum.

ARGENTINE REPUBLIC.

Prof. L. Brackenbusch, who has surveyed the area, states that there are vast stores of

petroleum here, especially in the province of Juyjuy. It also forms surface-lakes, crusted over with pitch and asphalte.

EGYPT.

The petroleum on the western border of the Red Sea, at Jebel Zeit, has been known from the earliest times; it is probably from this spot that the Egyptians obtained the supply for embalming. At Jamseh, thirteen miles south from the wells of Jebel Zeit, a few explorations were made several years back, and more recently they were resumed in both localities by the Egyptian Government.

Borings of 30 to 40 metres deep met with oil; subsequently deeper trials were made, some to 500 feet, but without further success. The petroleum occurs in tertiary strata, dipping to the last from the range of the old rocks which form the high ground of the Arabian Desert.

ALGERIA.

Petroleum springs were discovered about ten years back in Algeria, in the eastern part of the province of Oran, at Ain Zeft, nearly midway between Cassaigne and Renault. Here the beds are of lower tertiary age; they dip at a high angle from N.N.W. to S.S.E. The petroleum, with salt water, comes out of grey and blue marls with gypsum and sulphur.

Very little has yet been done to explore these deposits. The importance of any considerable amount of petroleum near the shores of the Western Mediterranean is obvious. As regards local consumption, there is the protection duty on imported petroleum, which may allow workings to be made at a profit.

INDIA.

The petroleum of India occurs in middle or lower tertiary rocks along the flanks of the Lower Himalayas, generally where the beds are highly inclined. Frequently it occurs in the neighbourhood of salt deposits, or is associated with saline water. Explorations have at various times been carried on at numerous points, full descriptions of which are given in the "Manual of the Geology of India," by Medlicott, Blanford, and Ball; in a later paper by Medlicott, in vol. xix. of the "Records of the Geological Survey of India," and in Mr. Redwood's paper read before the Society of Chemical Industry, April 21st, 1890.

Petroleum seems to be unknown in Peninsular India. The petroleum field of Baluchistan lies in the Mari Hills; at Kháfan, in a boring

524 feet deep, oil was obtained on seven horizons. The petroleum of the Panjáb, of which great things were once expected, seems to be of small value, and Mr. Medlicott thinks it the least productive of the Indian areas.

The petroleum of Assam seems to be of some importance; it is generally found in the coal-bearing beds of the Middle Tertiary. At Makum oil springs occur, and borings were here made to a depth of nearly 200 feet, when oil rose to within 44 feet of the surface. From one bore-hole 1,500 gallons were drawn in twelve hours, after which the flow varied much, occasionally reaching the original rate. In one hole, 200 feet deep, the oil spouted for a time, with a pressure of 30 lbs. to the inch.

BURMAH.

The petroleum of Burmah* occurs in the upper tertiary strata, probably of the age of the Swalck formation in India.

The oil occurs in soft sandy beds, covered by a stiff blue clay, chiefly on the top of an anticline, the beds on each side dipping N.E. and S.W., at angles up to 35°.

The petroleum fields are those of Beme and Twingoung. In Twingoung, of 236 productive wells, only 30 were 300 feet, the deepest being 310 feet. In Beme, of 72 productive wells, the deepest was 270 feet.

Some of the wells have been productive for 100 years, but with pumping no doubt this duration would be considerably reduced.

The maximum production is under 5 barrels per day; most produce only about one barrel.

Along the Arakan coast, from Cheduba Island northwards, there are mud volcanoes with hydrocarbon gas. Petroleum there occurs at Boronga Island and Ramree Island.

The rocks, of tertiary age, are crushed together and greatly folded. Wells have been drilled to a depth of over 1,200 feet; for a few weeks one well yielded 1,000 gallons daily, but the total production from 11 wells for a year was only 234,300 gallons.

Petroleum occurs also in Pegu.

JAPAN.

This area has been described by Mr. Lyman. Petroleum occurs in tertiary strata probably pliocene. The oil-bearing rocks are folded, with the axes of the folds running nearly north-east and south-west, the folds being frequently reversed; where so, the reversed dip is towards the neighbouring sea-

* Noertling. Records of the Geological Survey of India, vol. xxii. p. 73. 1889.

shore—to the north-west in Echigo, and to the south-east in Tootoomi. This structure is further complicated by another series of folds, running nearly north and south. As would be expected in such a disturbed area, none of the wells flow, the oil is raised in buckets. The wells range up to over 700 feet in depth. The production in 1884 was about 4,750 tons; in 1882 it was nearly 3,530 tons. Petroleum has been recorded from Seghalien, the large island north of Japan.

CHINA.

Natural gas has long been known and utilized here. It was discovered in sinking artesian wells for brine. There are borings for gas 3,000 feet deep in the district of Tsien-Lum Taing.*

NEW ZEALAND.

Petroleum occurs on the east coast of North Island at Poverty Bay, and at Waiapu, East Cape; borings to a depth of about 1,000 feet have been made. The rocks of these districts are cretaceous and tertiary.

On the west coast of North Island, at Sugarloaf Point, Taranaki (New Plymouth), a heavy oil oozes from cracks in a trachyte-breccia; wells have here been bored to a depth of many hundred feet, but no considerable supply has been obtained.

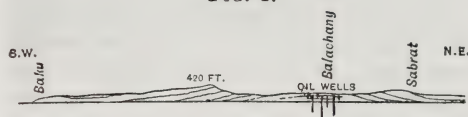
THE CAUCASUS.†

The Baku district and its wonderful productiveness have been too often described to make it necessary to say much on this point on this occasion. Mr. Marvin's numerous publications made the region well known to English readers.

Although petroleum occurs all along both flanks of the Caucasus, often in considerable quantity, the Apscheron peninsula, on the western margin of which Baku is situated, surpasses all others in value. The most productive wells lie within a small area north-east of Baku, in the Balakhany-Saboontchi district, over (as Abich long ago pointed out) the crown of a low anticlinal, which is probably the easterly continuation of the great Caucasus anticlinal.

Another, and an increasingly important productive area, is on the shores of the Caspian at Bibi-Eibat, south of Baku, and about ten miles from Balakhany.

FIG. 2.



SECTION THROUGH THE OIL WELLS NEAR BAKU (ABIEH). Length about 12 miles.

The wells here are, Mr. Redwood informs me, 50 per cent. more productive than those of the Balakhany-Saboontchi district.

The surface is occupied by loose sand, the rocks below being of late tertiary date; beneath these probably lie the cretaceous and jurassic strata, which form the main mass of the Caucasus, but it is doubtful if any borings have touched these rocks.

Natural springs of petroleum, gas, salt-water, and mud volcanoes have long been known here; and the Persian fire-worshippers have from early times looked upon this as a sacred spot. A temple is built over some natural gas springs at Surakhany, but this is now deserted.

The oil lies in various layers of sand, separated by clay, &c. This sand is often very loose, and comes up in great quantities, where oil of high-pressure is first tapped, flooding the country for some distance round. Enormous loss of oil often occurs when a high-pressure well is first driven. The Mining Company's well in August, 1887, struck oil at a depth of 790 feet, which flowed the full size of a 12-inch pipe for 69 days, 200 feet above the derrick. The lowest estimate for this well for the 69 days was 3,000,000 barrels, of which at least half was lost. More sand than usual came out of this well; an area of about ten acres around the well was covered with sand from one to fifteen feet thick. So much sand has been carried out by the wells that the surface of the ground sinks, and buildings are thrown out of the perpendicular. During last month (March) a new well threw up petroleum at the rate of over 35,000 barrels per day, running away to waste for several days. All such sudden influxes of oil lower the price. This last well is said to have caused a reduction of 30 per cent.

In 1886, a well at Bibi-Eibat, which had given oil at shallow depth, was continued to a depth of nearly 700 feet, the deepest in that district, this producing from 30,000 to 40,000

* Mr. Redwood informs me that important petroleum-fields exist in Java, Sumatra, and Borneo, which are now being explored.

† This part of the paper was illustrated by a series of photographs, recently taken and kindly lent by Mr. Hume, F.G.S.; they had been copied, as lantern slides, by Mr. F. W. Amsden.

barrels daily for fifteen days, when the flow entirely ceased. Many highly productive fountains have suddenly ceased in this manner; the cause is said to be a collapse of the pipe at the bottom of the well.

The depth of the wells in the Baku area is gradually increasing: in 1882 the average depth was 350 feet; in 1886 it was 500 feet. Many are now over 700 feet, and at least one is over 1,000 feet.

The wells sometimes continue to produce for years, especially when, as in Nobel's works, the wells are sealed down when not required. The deeper wells as a rule produce the larger quantity, and sometimes a better quality of oil, of lower specific gravity.

Large numbers of wells, of from 200 to 600 feet deep, produce from 200 to 600 barrels per day. A few of greater depth yield 1,500 gallons, or more. The great fountains alluded to above are of course exceptional, and rarely maintain this enormous flow for a long time.

There is a difference of opinion as to whether wells affect the production of others in their neighbourhood. If they all obtain the oil from the same bed, it is highly probable that they do. But there are several layers of oil-bearing sand, and adjacent wells may frequently draw their supplies from different beds.

It is said by H. Sjögren, who has minutely examined the petroleum region, that the yield of the wells varies with the state of the barometer and the direction of the wind. It is difficult to see how these causes could have influence on the high-pressure wells, but the observations may apply only to the smaller wells.

Mr. Redwood has given me the following statistics as the production of the Baku oil-fields (in tons):—

1863.. 5,484	1887.. 242,000
1864.. 8,700	1878.. 320,000
1865.. 8,900	1879.. 370,000
1866.. 11,100	1880.. 420,000
1867.. 16,100	1881.. 490,000
1868.. 11,900	1882.. 680,000
1869.. 27,180	1883.. 800,000
1870.. 27,500	1884.. 1,130,000
1871.. 22,200	1885.. 1,838,709
1872.. 24,800	1886.. 2,419,354
1873.. 64,000	1887.. 2,338,709
1874.. 78,000	1888.. 2,821,935
1875.. 94,000	1889.. 3,314,516
1876.. 104,000	

The most important area of the Caucasus, after Baku, in some respects, is that of Kouban.

This lies at the north-western end of the range. The wells here are usually of smaller depth, and are less productive than at Baku, although one well—as far back as 1879—is said to have been bored to a depth of 1,020 feet; and, in 1866, several thousand barrels of oil per day were given by one well for a considerable time. Here, as at Baku, the heaviest oil sometimes comes from the higher beds.

The third productive area is near Kertch, in the Crimea. The wells here are not deep, and, compared with the two other districts, are not highly productive. One well, however, has been carried to a depth of 940 feet, and produced about 30 barrels per day for a time, its total production being about 3,500 barrels.

Around the Caucasus there are several other petroleum fields, which will rise in value when the highly productive district of Baku declines.* Attempts have recently been made to work those near Batoum.

There are comparatively few petroleum areas in the interior of Russia; but oil has been noticed in the governments of Samara, Simbirsk, Kazan, and elsewhere; it is also recorded from Petchora in Archangel. Silurian and Devonian rocks, often very fossiliferous, underlie large areas of central Russia, being covered up by secondary strata. These old rocks are but slightly disturbed, and it is possible that in their anticlinal folds they may contain stores of gas and oil. So long, however, as the Caucasian petroleum fields are productive, there will be no great inducement to undertake expensive and perhaps fruitless exploration in new regions. In the future, however, it may be well to see if the conditions affecting the storage of petroleum in the palæozoic rocks of the United States and Canada are repeated in Russia.

THE CARPATHIANS.

The most important petroleum fields skirt the Carpathians, especially along their southern, eastern, and northern flanks. In Roumania, petroleum lies in clays and sandstones of the "Paludine Beds" (miocene). The oil occurs in four horizons, the lowest being the richest in gas and oil. Argillaceous beds, with thick deposits of salt, occur under the Paludine Beds; this salt is of great thickness, over 650 feet. Formerly the petroleum was extracted by shafts of more than 600 feet in

* For an excellent account of all this area, and also of Eastern Europe generally, see articles by Herbert Tweddle, jun., on the "Petroleum Fields of Europe," in *Engineering* January-April, 1886.

depth ; about 400 such shafts have been sunk in the neighbourhood of Sarata. When drilling was introduced, the beds were pierced to a depth of 1,300 feet.

Campina, about forty-five miles west of Sarata, is another important petroleum district. Wells have been drilled to a depth of 1,200 feet.

Petroleum and salt are worked in Bukowina.

In Galicia petroleum occurs, namely, in the lower eocene beds, but sometimes, perhaps, in the upper cretaceous. The strata are for the most part highly inclined, generally dipping away to the north from the Carpathian highlands, but the beds are often contorted. Dr. Paul's sections of this district show that petroleum frequently occurs in anticlinals of the folded strata.

FIG. 3.

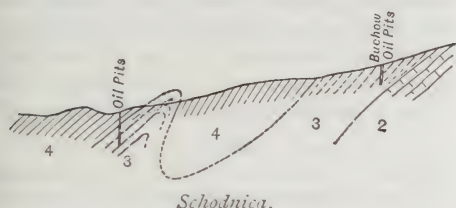


FIG. 4.

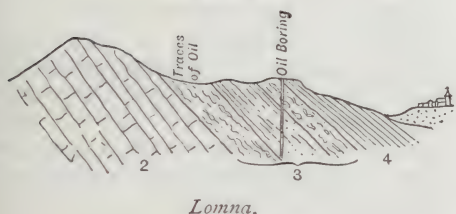
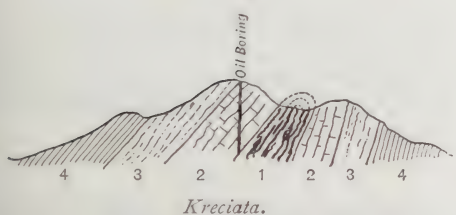


FIG. 5.



SECTIONS ILLUSTRATING THE MODE OF OCCURRENCE OF PETROLEUM IN GALICIA (C. M. PAUL).

Petroleum has long been known to occur in Galicia, but it has not been much sought for till recent years. Borings now go down to over 1,000 feet ; oil, sometimes with much gas,

being chiefly found in beds of sandstone. Mr. Nelson Boyd has recently described this district*.

The district around Sloboda was formerly the most important petroleum field. The development has progressed to the west along the line of the petroleum belt, and in the district of Ustrzyki a very important area has been opened up. The wells do not yield large quantities of oil ; but they last for a comparatively long time.

Ozokerite occurs generally over the Carpathian area, but it is of special importance in Galicia.

Mr. Redwood gives me the following figures as the production of crude petroleum in Galicia :—

Barrels.	Barrels.
1882..130,000	1887.. 530,000
1883..170,000	1888.. 670,000
1884..230,000	1889.. 750,000
1885..330,000	1890.. 817,000
1886..440,000	1891..1,000,000
	(Estimated.)

In Poland petroleum occurs at Wojeza, in the government of Kielce ; it is found in sandstone, intercalated with shales, in miocene beds.

In South - West Hungary, Croatia, and Slavonia, Dr. J. Noth describes the petroleum as occurring in folded strata ; sometimes along anticlinals, sometimes where these anticlinals have been bent over to the north-east, so that a boring goes twice through the same bed.

Further south, petroleum is known in Bosnia, Bituminous matter also occurs in pliocene gravels of Selenitza in Albania. No petroleum is yet known in Bulgaria or Servia ; but in the latter country the eocene strata are rich in bituminous schists. They also contain thin beds of salt. The whole geology of this country is said by Dr. A. B. Griffiths to resemble that of the Galician area.

In North - Eastern Hungary, along the southern flanks of the Northern Carpathians, petroleum occurs in neocomian, middle eocene, upper oligocene, and in more recent strata. Exceptions to the general rule as to the occurrence of petroleum in ordinary cretaceous or tertiary beds are said by Noth to occur in parts of this district. To the south-east of Nagy-banya, in the Szatmar country, petroleum is found in a dolomitic limestone,

* Trans. Civ. and Mech. Engineers, for 1889-1890.

underlying mica-schist. In the Nagy-Banya basin, and also in the Matra range, it occurs impregnating trachytic tuffs of miocene age.

GERMANY.

In Bavaria petroleum occurs to the south of Munich, on the shores of the Tegernsee. Borings have been made to the depth of nearly 650 feet. The quantity of oil is not large; it occurs in the Flysch (here of lower tertiary age), a series of hard shales, grits, and impure limestones, which form a zone along the northern flanks of the Bavarian highlands. The beds are sometimes nearly vertical, or they dip at a high angle to the south, in which case they may be reversed.

Beds of asphalt and bituminous schists occur in the district. Dr. V. Gümbel states that these by distillation yield an oil like that of the Tegernsee. He concludes that the petroleum has been thus produced.

In Elsass petroleum occurs at Schwabweiler, impregnating beds of sand and sandstone, which are mainly of lower oligocene age, but perhaps partly middle oligocene. Borings have been made to a depth of 950 feet. At Hirzbach the oil occurs in dark coloured clays, in the lower part of the middle oligocene. All the petroleum strata yield brine. Dr. Andreae thinks that the petroleum here was formed in the rocks in which it is now found. Piedboeuf and Strippelmann think that it has impregnated them from underlying strata. Petroleum also occurs at the foot of the Eastern Vosges, from Worms to Basle.

The petroleum fields of north-west Germany are of some interest to us, as being those nearest to England, and also because they probably, to a great extent, represent the state of things to which we must look forward when gushing wells and great petroleum "pools" are exhausted.

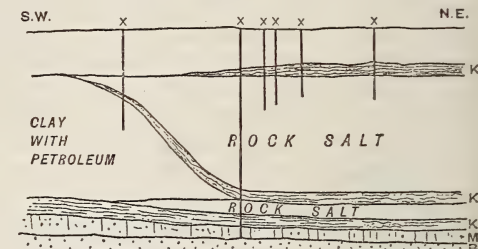
At Oelheim, on the east of Hanover, we have a number of wells, often not more than 30 yards apart, all yielding small quantities of oil, with much salt water. Borings, some years back, discovered oil at Horst, a few miles east of Oelheim. Some wells are now in progress here. At the eastern part of Oelheim the oil is stored in the gault. There seems, also, to be some in the wealden beds, and in the upper jurassic strata. To the west there are triassic beds; but these seem to be mostly barren of oil, although Piedboeuf believes that the fossiliferous middle trias *Muschelkalk*) is the true source of the

petroleum, which has been stored in the overlying beds.

The occurrence of petroleum in the gault is at first somewhat surprising, because we in England know the gault best as a stiff impervious clay. But it is not always in this condition; in its westward range in England it becomes more sandy, and at Oelheim it is a rather sandy clay. Some clays seem to have a curious affinity for petroleum, which enables them to contain more oil than we should expect. It has often been noticed that petroleum which runs to waste down a river bank will generally float on the water, but if the banks consist of soft clay, the oil trickles down under the water, and soaks into the clay.

At Horst, petroleum was first found in the gault; recent borings passed into lower strata—probably wealden—and then obtained oil in larger quantities. Here, as is frequently the case, the lighter oil came from the lower bed. Petroleum also occurs at Wietze and Steinfürder, near the River Aller, some miles north of Hanover; here it lies in the keuper beds, in the immediate neighbourhood of rock-salt.

FIG. 6.



K, Keuper marl; E, Muschelkalk; B, Bunter sandstone. ** Boreholes (the deepest is 1,500 English feet, with 960 feet of rock-salt).

SECTION OF STRATA AT STEINFÜRDE, N. OF OF HANOVER (STRIPPELMANN).

The petroleum of Hanover has been known for a long time. It escapes from the gault and other beds, to which it properly belongs, into the drift sands, and then appears at the surface.

ITALY.

Petroleum springs are widely distributed along the northern flanks of the Appenines, from near Bobbio on the west to near Imola on the east; oil impregnates the rocks, which are mostly of eocene age, so that wells are frequently contaminated. Petroleum has long been worked at Monte Gibbio. Gas, petroleum, and salt water issue in small mud

volcanoes; the *Salsa di Sassuola* and the *Salsa di Quersola* being perhaps the best known. The natural gas of Barigazzo has long been famous; but gas issues at many other points. In 1887, Italy produced 208 tons of petroleum and 18,507 tons of asphalt and bitumen.

FRANCE AND SPAIN.

Petroleum occurs on the flanks of the Puy-de-la-Poix, east of Clermont, flowing from the calcareous peperino, of which the Puy is composed. Borings, recently made near the village of Lussat, are said to have met with natural gas at a depth of 450 feet. Petroleum is also known near Gavian, in Hérault, and near Grenoble. It occurs in numerous places along the northern flanks of the Pyrenees, in cretaceous and tertiary beds.

Petroleum is found near Burgos; and also, in cretaceous beds, in Catalonia.

UNITED KINGDOM.

Petroleum and natural gas occur but sparingly in the United Kingdom, so far as is yet known; the latter, indeed, only in sufficient quantity to be a source of danger and annoyance in working mines. The gas of coal mines is but too well known; it occasionally comes off in "blowers" in considerably quantity, but these are fortunately soon exhausted. The gas is stored, under pressure in fissures of the coal and associated strata, but it also occurs generally distributed throughout the pores and small interstices of some coal seams, and then is given slowly off in small quantities. Mr. Kinahan has recently suggested that the gas of coal mines might be collected in pipes, and brought to the surface for use, as has been attempted in the United States. But probably the gas is too small in quantity and too irregular in occurrence to enable this to be profitably carried out. Gas found at Wallsend Colliery burnt for several years, and a proposal was made to take it in pipes to the Newcastle Gasworks, but the yield declined.

Gas occurs in the jet-rock of the upper lias in East Yorkshire, along with some heavy liquid bitumen. The gas sometimes finds its way down into the ironstone mines worked in the middle lias. Mr. G. Barrow informs me that one blower burnt for over twenty years in the Crag Hall ironstone mine, a few miles south-east of Saltburn. The jet-

rock of the upper lias in Yorkshire often has liquid bitumen in the beds and inside the fossils, especially in the ammonites.

Bitumen, in various forms, and in small quantities, is not uncommon in the fossiliferous Palæozoic rocks of England. Petroleum occurred in the Deep Main Pit at Riddings Colliery, Alfreton, Derbyshire; and in larger quantities in Southgate Colliery, near Chesterfield, from the roof of the "top hard" coal. Petroleum, in small quantities, has frequently been found in the Derbyshire lead-mines, which are worked in the carboniferous limestone; gas also occurs in these mines, which has sometimes caused explosions. The mineral statistics of the United Kingdom give the following as the production of petroleum in Derbyshire:—1886, 43 tons; 1887, 66 tons; 1888, 35 tons; 1889, 30 tons; 1890, 35 tons; the whole of this is from the Southgate Colliery. Petroleum is found in the sandstone beds in the coal measures of Shropshire: some of it was sold years ago under the name, "Betton's British Oil."

From the very frequent occurrence of saline water in most petroleum-bearing beds, we might occasionally expect to find that petroleum or gas occurs with rock salt; but this seems to be seldom the case. Marsh gas has been noticed, although rarely, in rock-salt mines at Northwich and Winsford, but only in small quantities. In north-west Germany, and also in Roumania, rock salt and petroleum occur in closely associated strata, but not together.

Gas was found in the early borings for salt at Middlesbrough; and at the Seaton Carew boring some oil was obtained. In both cases the source probably was the upper beds of magnesian limestone, with which the salt deposits are associated—if present. A deep boring at Port Clarence was carried 150 feet below the salt, in order to prove the magnesian limestone. The limestone contained traces of bitumen, and there was also a constant escape of gas, which contained 83.2 per cent. of hydrocarbons, and 16.8 per cent. of nitrogen. Recently, gas has been found in greater quantity and under considerable pressure, with some petroleum.

Brine is sometimes found in working seams of coal in the coal measures of England and Belgium. In the latter case it is not, and probably rarely is in the former case, due to the presence of salt-bearing Keuper marls over the coal. It has often been surmised that this salt water belongs to the coal measures, and some have held that it

is fossil sea-water, having been imprisoned there since the formation of the coal. Although coal has generally been formed in fresh water swamps, there are occasional marine bands, showing that the sea had access at times to the area.

In the deep pit at Dukinfield, a strong brine spring was met with. It is interesting to notice that a little petroleum issued with the water. This pit is sunk through the Permian strata to the coal measures. The Keuper marls are about twenty miles distant.

An interesting discovery of petroleum, but only in small quantities, has recently been made at Bellagio, near East Grinstead, in Sussex. A boring there in search of coal is traversing the Wealden beds, and at from 512 to 521 feet passed through a bed of sandstone impregnated with petroleum. The associated Wealden shales are in places crowded with fossils.

Contrasting these meagre indications of petroleum with the great stores of other countries, we naturally ask, why such small quantities have as yet been found in England, and whether the knowledge already gained in other areas will avail us for prospecting for gas in this country? Our strata are for the most part as fossiliferous as those of petroleum-bearing regions. Why then have not the same processes of petroleum production taken place here, and why has such petroleum as may have been formed not been preserved?

The first suggestion is that our fossiliferous Palæozoic strata have been folded and denuded repeatedly, so that at various different ages their denuded edges have been exposed, and the gas or petroleum which they may have contained has had every chance of escaping.

Judging from what occurs in Ohio and Indiana, we might suppose that the Palæozoic rock most likely to act as storage for petroleum would be the magnesian limestone of Durham, but the edges of this are well exposed; moreover it is not in itself fossiliferous.

The marl-slate below it frequently contains abundant fish-remains, and below this there are the carboniferous rocks. Unfortunately, however, the magnesian limestone lies unconformably upon the denuded edges of the coal measures and the carboniferous limestone; and it is more than likely that the volatile hydrocarbons of these rocks had escaped before the magnesian limestone was formed. Should the magnesian limestone, in its porous cavernous condition, underlie much of north-east Yorkshire, and there be itself underlain by

beds which can supply it with hydrocarbons, we may perhaps hope for gas or petroleum from beneath the anticlinals which traverse the Yorkshire oolites. Perhaps the gas said recently to have been discovered at Middlesborough comes from the magnesian limestone.

Mr. G. H. Kinahan, in a paper recently published, says*:—"As far as the Irish ordovicians are concerned, there are in these strata more or less like the oil and gas rocks of Ohio ordovicians, as in those of county Cavan. Some of them are so like not only the Ohio, but also some of the Canadian rocks, that in a paper on 'Irish Metal Mining,' recently read before the Royal Geographical Society, Ireland, I suggested that trials for oil and gas might be made by boring. There are also places in Wexford and Wicklow with good-looking strata."

In North-West Germany, as we have seen, the fossiliferous *muschelkalk* is probably one chief source of petroleum; this formation does not occur in England.

Many of the oolites of central England are very fossiliferous, and porous beds interstratified with impervious shales occur amongst them. Several instances have of late years occurred of saline water being found in these beds, and it has been supposed that this is due to the passage upwards of brine from the Trias. But the constant association of saline water with petroleum may suggest another origin for this. It may be, however, that all the petroleum and gas have escaped, and that only the saline water now remains.

The Sub-Wealden Boring in Sussex (1872-5) was favourably placed for discovering petroleum, if such existed in that area. The Oxford and Kimeridge shales there are very fossiliferous. Between them come calcareous sandstones, of Corallian age. Above the Kimeridge clay, there are Portland sands, all sealed above by impervious shales of the Purbeck series.

Here, then, we have fossiliferous shales to yield the petroleum, and sandstone in which it could be stored. Moreover, the site of the boring was purposely placed on the summit of an anticlinal. But no petroleum was observed. Many beds of the shales, however, were highly bituminous, and possibly the hydrocarbons, resulting from the decomposition of the fossils, were there present.

* "Marsh (Natural) Gas," "Trans. Manchester Geol. Soc.," vol. xix., p. 121; 1887.

CONCLUSION.

In glancing over the ground we have traversed this evening, I am but too well sensible of the fact that prominence is given to some areas which are now of comparatively little value, whilst the great petroleum fields of the world are but briefly described. But for this there is some good reason. The American and Russian areas have been repeatedly described, and full accounts of them are accessible to all, but information as to other districts is less accessible. Further, there is some reason to believe that these great districts have seen their maximum development, and as the use of petroleum is increasing, other and less favoured fields will be opened out. It is, therefore, of some importance to know under what conditions gas and petroleum occur in various districts, at present but little regarded by the world at large, but which may hereafter become of some importance.

Some misapprehension exists as to the duration of the American gas and petroleum fields. The production has continually increased, until within the last few years; and the diminution is attributed to restrictions upon the output. It is, therefore, inferred that the oil fields show no signs of failure. But if we examine the records of the productive areas separately and in detail, we shall see that each one has rapidly developed, and then has slowly declined. Some which once figured largely in the statistical returns now add little or nothing to the total yield.

The increased production is due to the discovery and development of new productive areas. This is especially the case with districts of high-pressure gas or oil, whereas low-pressure fields have longer lives. The chief

exception to this rapid exhaustion of high-pressure areas is Baku; but even here there are said by some to be signs of exhaustion.

The history of all high-pressure wells is substantially the same: first, an enormous supply, and then signs of brine, followed by an increasing quantity, which finally spoils the well. To yield brine, with only a small proportion of oil, is the final stage of almost all high-pressure wells. It is true that the small supply of oil with much brine may continue for several years.

Such wells may pay in Germany, where there is a protective duty on imported petroleum, but they are at present worthless in highly productive areas. The time may, however, come when even the American Oil Men will return to their now deserted "pools," and be content with the small production of old wells, now shut down and abandoned.

The comparative permanence of low-pressure areas is a hopeful sign for the future of petroleum. What is most wanted is a steady production, not subject to enormous variations in quantity, and consequently in price. The whole subject may be fitly compared with the production of gold; the world was startled by the enormous yield of gold from the alluvial deposits of California and Australia; productive areas were successively discovered, which flooded the market with gold, altering the value of the currency, and demoralizing whole communities. We now look to a more steady production of gold from ordinary reef-mining.

Similarly with gas and petroleum, we may look forward to the time, probably no distant one, when the high-pressure areas will be exhausted, and when the world's supply will come from less abundant but more permanent sources.

APPENDIX.—IMPORTS OF PETROLEUM INTO THE UNITED KINGDOM (CUSTOMS RETURNS).

	RUSSIA.	UNITED STATES.	OTHER COUNTRIES.	TOTAL.
	Gallons.	Gallons.	Gallons.	Gallons.
1885	3,649,166	69,818,127	402,380	73,869,673
1886	2,708,370	68,034,623	508,743	71,251,736
1887	8,305,169	68,200,028	885,238	77,390,435
1888	20,867,826	72,217,660	1,315,799	94,401,285
1889	31,582,885	70,739,663	558,709	102,881,256
1890	33,103,280	70,903,026	1,174,557	105,080,863

DISCUSSION.

Mr. TOPLEY expressed his satisfaction that the son of Mr. Peter Le Neve Foster, so long the honoured Secretary of that Society, should be Chairman on the present occasion, being, he believed, the first time he had appeared in a public position since his appointment as Professor of Mining at the Royal College of Science.

Mr. BOVERTON REDWOOD said the paper might be divided under two heads—a general survey of the geological conditions under which petroleum occurred; and secondly, the general conclusions of geologists in the United States. In regard to the former division, he had felt some disappointment that the well-known and often quoted statements, which had been so agreeably put forward that evening, had not been accompanied by some general deductions, which would have formed an important practical addition to the knowledge of the subject. In respect to the United States he thought that the importance of the potentially petroleum-producing fields, other than in Pennsylvania and New York, had been rather underestimated; Ohio especially, though it was admitted that the production there had been very large. The conclusions at which he had arrived on his last visit to the United States were that there were deposits there yet undeveloped, and in some cases unexplored, which would probably, if properly used, prevent any serious decline in production for centuries to come. Some years ago he visited California, and while agreeing with Mr. Topley as to the character of the strata and the effect it had on the yield of the wells, he thought he had rather under-estimated the potential productiveness of the country. He saw one from which he was informed that a yield of 640 barrels a day had been obtained for some five years, and the aggregate yield of the district was 1,200 barrels a day. The yield, therefore, although not very large, was of local importance. He could hardly think either, that the cost of drilling there was three times as great as in Pennsylvania, though no doubt the inclined character of the strata rendered the operation more expensive. With regard to Canada, at the time of his visit he found the average production of refined oil, from crude, was 42 per cent., though a somewhat high test was required by law, and had been for some time. He thought too little had been said of Peru as a source of petroleum, in the light of recent knowledge. With regard to the character of the yield in that country, only recently Dr. Tweddle informed him that he was afraid to drill to any considerable depth, and had only perforated the outer crust of the oil-bearing shale, because of the immense violence with which, at the moderate depth to which he had gone, the oil was ejected from the well. [The speaker here criticised the description given of the Baku oil district. The information thus given is now incorporated by the author in the text

of his paper.] The salient characters of the Baku fields, as a whole, was not only their great productiveness, but the regularity of the yield; in oil miner's language, there was an extremely small number of "dry holes," and it was hardly possible to drill a well in the district without getting a considerable quantity of oil. Very recently a lower oil-bearing formation had been penetrated at a depth of 1,450 feet, the greatest depth before having been about 1,100 feet. The natural gas in the fire temple at Surakhany still flowed, for he himself ignited it with a match. The average depth of wells in the Baku district had recently been increased to 700 feet, a large number being over 1,000 feet, and the average of 700 feet was the considerable proportion of those of moderate depths. The statement that the oil obtained from the deeper wells was as a rule lighter, was true of some districts, but not universally. A well in the Balakhany field of only 250 feet, yielded a large quantity of very light oil; and this particular well lay quite outside the line fixed by an eminent Russian geologist, and where he said it would be quite useless to drill. In fact, in the case of Baku, no very useful information had been obtained from geologists. There was another field, which gave much promise, Gruzino, near Vladikavkaz, which was only 150 miles from the railway, and might ultimately become of great importance. Roumania, if properly developed, might become a very important source of supply, and the geographical position would facilitate distribution. In Galicia, though the industry was really as old as in the United States, it was still in its infancy, and a very large portion of the country was still undeveloped. With regard to the East, he thought Mr. Topley hardly appreciated the recent developments in Burmah; and Java, Sumatra, and Borneo might also be referred to. He did not agree that this industry had reached its zenith, either in the United States or Russia, for in the former there were large tracts, known to be petroliferous, not yet developed. In the Balakhany-Saboontchi field not one half the area had yet been drilled, and in Bibi-Eibat not more than one-tenth; and, besides, there was every reason to believe that there were enormous areas of oil-producing territory outside these limits. But, while he could not agree that new sources should be sought, because the old ones were giving out, he was quite of opinion that every encouragement should be given to the development of new districts, on account of the enormous increase in the application of petroleum to industrial purposes, and especially the wonderful strides which were now being made in the use of the oil as liquid fuel, and as a source of illuminating gas.

The CHAIRMAN, in proposing a vote of thanks to Mr. Topley, desired first to thank him personally for a few kind words he had said with regard to his father, and, if he might be allowed, to add a word

of his own on the same subject. He recollected the time, some thirty-nine years ago, when his father, as a member of the Council, before his appointment as Secretary, had a chief share in establishing the weekly *Journal of the Society of Arts*. He believed his father was the originator of publishing the Wednesday evening paper, with the discussion which followed, on the following Friday; an excellent plan, which had scarcely yet been adopted by any other scientific society in London. It was a matter of great congratulation to himself that his first appearance as chairman of a scientific meeting in London should be on the occasion of a paper by his old pupil in geology, and his friend and colleague on the Geological Survey, Mr. Topley. Coming to the matter in hand, it was very necessary to appreciate the immense importance of this petroleum industry, which had grown up so gradually, that few realised its magnitude. The imports into this country now exceeded 100,000,000 gallons yearly, and the annual value was considerably over £2,000,000, a much greater amount than the value of any mineral in this country, except coal and iron ore. From a social point of view also, petroleum was most important. In his winter drives from the mines in North Wales, passing through the villages, and seeing the windows brightly lighted up by these petroleum lamps, he often thought what a comfort it must be to the cottagers, as compared to the state of things some years ago, when they had to depend simply on a home-made rushlight. Petroleum was a national civiliser, for if the working-man's cottage was better lighted than it used to be, he would be more likely to stay at home, his children would have better opportunities of learning, and he would be much less likely to visit the public house. Then there were the facilities for cooking to be considered, and, above all, its industrial applications. They had also to thank petroleum for great improvements in boring. The American method of boring by the rope was one which had been practised for many centuries, but American inventiveness had introduced very great improvements, of which we reaped the benefit. In drilling brine wells in the Middlesbrough district, advantage had been taken of American machinery, which did the work much more cheaply and quickly than that formerly used, and he was told by the representative of a large firm that they had totally abandoned the use of the old plant for small wells. In conclusion, he thought Mr. Topley deserved their thanks for the light he had thrown on the geological portion of the question, and for the word of warning he had given that the supply was not inexhaustible.

The vote of thanks having been passed,

Mr. TOPLEY, in acknowledging it, said he did not on that occasion appreciate the great blessing of having the paper printed on the ensuing Friday, for he had been so pressed for time in preparing his, that he should be very glad of a little delay for revision

and amplification. That accounted for some of the shortcomings referred to by Mr. Redwood, whom he thanked for his criticisms, and for some new points he had stated, having evidently more recent information. The statistics he (Mr. Topley) had given were generally from official sources, and this remark applied to the comparative cost of wells in California, which struck him as remarkable when he read it; but it was taken from a Government report. The paper was incomplete, and many points were omitted, or touched on more briefly than they should have been; but that arose from the cause he had stated. He was not prepared to admit, however, that on the main point he wished to emphasize, namely, the varying geological conditions under which petroleum exists, there was anything to alter.

Correspondence.

THE DURABILITY OF PICTURES PAINTED WITH OILS AND VARNISHES.

In the discussion on Mr. A. P. Laurie's interesting paper on the 8th instant, I am reported to have said, with reference to refining linseed oil by exposing it to light in the presence of water, that the *unoxidised* oil was heavier than water. The reverse is actually the case, the *oxidised* or solidified oil being heavier than water; the *unoxidised* is lighter.

The matter is of some importance, because several of the old Italian writers recommend the refining of linseed or nut oil in this way until no more "mucilage" is formed. As they estimate this mucilage at 50 per cent. in some cases, the substance thus produced must have been chiefly oil in the first stage of oxidation.

WALTER F. REID.

Fieldside, Addlestone,
April 14th, 1891.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

APRIL 22. — SIR GUILFORD MOLESWORTH, K.C.I.E., "Bimetallism."

APRIL 29.—WILLIAM ROBINSON, "The Use of Petroleum in Prime Motors." PROF. SILVANUS P. THOMPSON, D.Sc., will preside.

MAY 6.—E. L. FLEMING, "The Sources and Applications of Borax."

MAY 13.—PROF. J. J. HUMMEL, "Fast and Fugitive Dyes." SIR OWEN ROBERTS, Treasurer of the Society, will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoon, at Half-past Four o'clock :—

APRIL 21.—SIR THOMAS WADE, G.C.M.G., K.C.B., "China."

Tuesday evening, at Eight o'clock :—

MAY 5.—CAPTAIN J. BUCHAN TELFER, R.N., "Armenia."

Tuesday afternoon, at Half-past Four o'clock :—

MAY 26.—C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

APRIL 30.—COL. J. O. HASTED, R.E., "The Perriar Irrigation Project, Madras Presidency." The Right Hon. SIR MONTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MAY 14.—THOMAS WARDLE, "Description of the Growing Uses of Tussur Silk in the European Textile Manufactures."

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

LECTURE II.—APRIL 20.—Education of nature—Preliminary studies—Avoidance of symbolic plants—Choice of normal plants—Clearness in composition—Avoidance of artificiality.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 20 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Hugh Stannus, "The Decorative Treatment of Natural Foliage." (Lecture II.)
Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. W. P. Rix, "Stoneware and its Application to Chemical Apparatus."
Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Arthur Vernon, "Estate Fencing."
British Architects, 9, Conduit-street, W., 8 p.m.
Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m.

Surgeon-General Gordon, "Notes on Philosophy and Medical Knowledge in Ancient India."

TUESDAY, APRIL 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Sir Thomas Wade, "China."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. Scott Keltie, "The Geography of Africa." (Lecture IV.)

Civil Engineers, 25, Great George-street, S.W. 8 p.m. Discussion on Mr. R. E. B. Crompton's paper, "The Cost of the Generation and Distribution of Electrical Energy."

Statistical, School of Mines, Jermyn-street, S.W. 7½ p.m. Dr. J. Charles Steele, "The Charitable Aspects of Medical Relief."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. E. T. Newton, "A Skull of *Trogontherium cummeri* from the Forest Bed near Cromer." 2. Mr. H. Elwes, "Butterflies, collected by Mr. W. Doherty in the Naga and Karen Hills, and at Perak" (Part I.). 3. Mr. J. J. Lister, "The Birds of the Phoenix Islands, Pacific Ocean."

WEDNESDAY, APRIL 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Guilford Molesworth, "Bimetallism."

Geological, Burlington-house, W., 8 p.m. 1. Prof. T. G. Bonney and Major-General C. A. McMahon, "Results of an Examination of the Crystalline Rocks of the Lizard District." 2. Mr. F. Rutley "A Spherulitic and Perlitic Obsidian from Pilas Jalisco, Mexico."

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Second Spring Exhibition.

United Service Institution, Whitehall-yard, S.W. 3 p.m. Mr. G. Quick, "Heavy Guns and Heavy Shells, versus Light Guns and Light Shells, with some remarks on the Armaments of H.M. Ships *Victoria*, *Sans Pareil*, and *Benbow*."

THURSDAY, APRIL 23 ... Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 2 p.m. Annual Meeting.

Camera Club, Charing-cross-road, W.C., 8½ p.m. Mr. Frank Howard, "Photography in Bye Paths and Field Lanes."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Recent Spectroscopic Investigations."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

FRIDAY, APRIL 24...United Service Inst., Whitehall-yard, S.W., 3 p.m. Lieut. E. P. Girouard, "The Use of Railways for Coast and Harbour Defence."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Rev. Canon Ainger, "Euphuism: Past and Present."

Civil Engineers, 25, Great George-street, S.W. 8 p.m. (Students' Meeting.) 1. Mr. A. Sealy Allin, "A New Type of Water-Motor." 2. Mr. H. Evington, "Hydraulic Power, as Applied to Pressing-Machinery."

Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, APRIL 25 ... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Silvanus Thompson, "The Dynamo." (Lecture III.)

North-East Coast Institution of Engineers and Shipbuilders, the Athenæum, West Hartlepool, 7½ p.m. 1. Mr. H. Gray, "Water-gauge Fittings for Steam Boilers." 2. Paper by Mr. J. Petree.

Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.

Journal of the Society of Arts.

[No. 2,005. VOL. XXXIX

FRIDAY, APRIL 24, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the course on "The Decorative Treatment of Natural Foliage," was delivered by Mr. HUGH STANNUS, on Monday evening, 20th instant. The lecturer showed how it was possible to educate nature so that the foliage might be made to fill up the required spaces in the pattern, and be adapted to the designer's purpose. He laid great stress on the importance of clearness in composition, and pointed out by means of diagrams how this end might be attained, and how artificiality was to be avoided.

The lectures will be printed in the *Journal* during the autumn recess.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday evening, April 14th; T. ARMSTRONG in the chair.

The paper read was—

DECORATIVE PLASTER-WORK: MODELLED STUCCO-WORK.

By GEORGE T. ROBINSON, F.S.A.

Excepting to a few of my audience, I am afraid the title of my paper this evening will appear a *non sequitur*, for the plaster-work

which has been done during the present century can scarcely be called decorative, nor does it apparently come within the scope of the Section for Applied Art of this Society. Quite recently, however, there has been an attempt made to resuscitate it, and redeem its character; and no longer does the architect consider a cornice of "so many inches girth, with three enrichments to be selected by the architect," or "a centre-flower, so many inches in diameter, of approved design," all that he need trouble about specifying for decorative plaster-work. It is with the hope of, and in the endeavour to further, this redemption of a fine old art from the decadence into which it has so deeply fallen, that I venture to ask you to listen to me to-night, however uncongenial the title of my paper may seem to be.

The art of the plasterer has been no mean one. It dates from the best periods of antiquity, and I purpose to show you how that great artists have been great decorative plasterers in their day; and though their names are familiar to you in other walks of art, yet to their contemporaries they were equally celebrated for their works in this now neglected and ignorantly despised material. Of its redemption I have tangible ground for hope. Our departmental schools of art are turning out annually a very large number of men, instructed, to a certain degree, in the craft of modelling. Naturally, they yearn for great things, have visions towards marble, but too soon they find that these visions dissipate, and their yearnings are in vain. The great things they would do do not come to them, and disheartened, they gravitate into disappointed "modellers for the trade," deprived even of the ambition of individuality; for we have lost that branch of art which fed and educated so large a number of the practisers of the plastic art in olden times, and the largeness and breadth of design which was then acquired by decorative work has been killed by the necessity of the small highly wrought detail the "modeller to the trade" is now forced to consider the end and aim of his craft. It is then on their behalf, as well as on account of the intrinsic interest of the subject, that I now address myself to my subject and to you.

In the first place, then, let us consider what we mean by the term plaster. The term itself is a somewhat confused one, vernacularly embracing two very different things: one, the ordinary plaster of our walls—a finer kind of mortar, which I shall henceforward call stucco; the other, plaster of Paris, of which casts are

made. Stucco has for its base the ordinary carbonate of lime, generally the burnt limestone or chalk of our rocks and hills. Plaster has for its base sulphate of lime, prepared for use by burning gypsum or alabaster. The action of these two forms of lime is very different, but it will suffice for present purposes to say that stucco sets, or becomes hard, slowly, whilst plaster sets very rapidly. Stucco, when good, resists the action of the weather, and can be washed. Plaster, even of the best, perishes by exposure, and cannot be washed. You can model in stucco direct; plaster you must model for, in clay or other plastic material, and then cast in plaster, so that your labour is direct and single in the first and two-fold in the latter case. These two qualities have led to their differing use. I am now generalising. There are special variations which I shall not be able to touch upon this evening, but I want you to carry this distinction between stucco and plaster in your mind, so as to avoid confusion.

The properties of both stucco and plaster were well known to the ancients, but as the full knowledge of that of stucco was arrived at very early, whereas that of plaster did not reveal itself until comparatively modern times, I shall confine myself this evening to the consideration of stucco alone.

Stucco is, as I have told you, a superior kind of mortar, but both it and mortar were much more carefully compounded in the best days of ancient art than they are now. The lime was very carefully selected, carefully burnt with wood, very slowly slacked—and that a long time before using it—and very carefully mixed with sand, or even marble dust; and, in the old mode of preparing it, there were two important ingredients, of which we have become, not economical, but parsimonious, time and care. Vitruvius, who wrote on architecture about 2,000 years ago, gives minute and careful instructions as to its preparation; and so good was the stucco of those days, and so hard and smooth did it set, that he records the use of it, when polished, for mirrors; and I have seen stucco that had been laid on centuries before he wrote, which was, even when I saw it, in better condition, and less time and weather-worn than the marble which was placed alongside it; and even at Mycenæ the stucco used in archaic times yet exists.

This was the stucco for walls and plain surfaces to which painting was generally applied. Seeing, then, that the Greeks knew so well the

properties of stucco, and that so carefully prepared and eminently plastic a material could be readily modelled into relief ornament, it is but natural to suppose that they used it in such manner. Unfortunately, of this we have no direct evidence. Nor is this greatly to be wondered at, for not a vestige of the private or public buildings of the palmy days of Greece is extant, save only the bare broken skeletons of their temples, and, of course, in these the ornaments and decorations would be of the costliest and most valuable materials. But that stucco reliefs were used, even in the temples, is evident, for Pausanias, who wrote about A.D. 174, says that he saw in the roof of the Temple of Diana at Stymphalus, figures of the Stymphalides, or the harpies, which were of stucco or of wood, he could not determine which, but conjectured of wood. Still, the fact that stucco suggested itself to him as one of the probable materials, points to its general use; for though I cannot produce any direct evidence, or name extant remains of Greek stucco modelling, yet this is by no means evidence for its non-existence.

Those despoilers of Greece, the Romans, carried off the artistic treasures of Greece to adorn Rome, and with them they, in all probability, carried the art of the decorative stucco worker. It is, therefore, as an Italo-Greek art that we actually know what ancient stucco decoration was. In the South Kensington Museum are several *plaques* of it, executed with great freedom and spirit, in some of which the red terra cotta tile, which forms their base, plays an important background to the cameo-like treatment of the modelled stucco work; and though these may probably not be anterior to the first century of the Christian era, they show an ability and dexterity of manipulation which must have been begotten by long experience.

At Pompeii there are abundant records of its use, some of the work being in very low relief, as on the tomb of Scaurus, which was painted and gilded, and was not much more prominent than Chinese lacquer work. Nothing, however, of very high artistic quality has been found there. But then Pompeii was only a sort of Margate to Rome, nor should we seek at our Margate for the finest 19th century decorative art. When we come to Baïæ, which was a more opulent place, the stucco decorations were of much finer character. Unfortunately, none of these are now left, though so late as Winckelmann's time, that is to say about 1750, there was much still

existing; *virtuosi* and earthquakes have since then destroyed them all.

Naturally, it was in Rome itself that this popular art was more excellently practised, though of course there is now very little evidence of it remaining. What it was in the first century may, however, be seen by the fragments which were discovered in making the excavations for the canalisation of the Tiber, in the neighbourhood of the Farnesina. These embrace a series of panels surrounded by a double row of "egg-and-tongue" mouldings, and filled with figures of winged victories and genii, with occasionally larger subjects. One of the larger subjects, a Bacchic sacrifice, I am enabled to show you on a larger scale, from which you will see that this early stucco work is of exquisite beauty, equal to the finest sculpture in its execution, and as pure in design as though it were for the costliest gem engraving. It would be impossible to over-value the lesson this teaches, that no matter how simple the material, the art enshrined in it should be the best the artist can give. The margins and friezes outside these panels have running ornaments of chimera and other *grotteschi*, of most delicate work. Casts of some of these fragments, I am, by the kindness of the authorities at South Kensington, enabled to exhibit to you this evening, as well as some photographs of them as they were found. You will find them very well worth your careful examination, and will observe how eminently Greek they are in delicacy and style. Such art as this, which dates from the first half of the first century of our era, could not then have been acquired in Rome, it could not have been attained to without long experience; its expression bespeaks the country of its origin, and, in my opinion, removes much doubt from the somewhat uncertain evidence of the use of modelled stucco work by the great artists of Greece. These fragments are very precious to us, as they are almost all we have of so early a date, but there did exist others which in the early part of the 16th century played a most important part in the revival of this branch of art, which naturally in the decadence of Rome, and the barbarism which followed it, passed into the limbo of forgotten things.

Its resurrection was thus. When, in 1488, Giovanni de Medici was created a Cardinal at the early age of 13, his father Lorenzo the Magnificent wrote him a letter of advice as to his future conduct: "Do not array yourself, said he, in silk and jewels; such things are not for you,

but the collection of objects of antiquity and rare books beseeem you better." The Cardinal bettered this instruction, and in seeking for sculpture of classic times made excavations amongst the ruins of the Golden House of Nero, or as it was then called the Baths of Titus; he was rewarded by some statues, but for our purpose he made a more important discovery in the rooms of this buried treasure house. These abounded with paintings, and were largely adorned with stucco work of fine quality, both as regards design and material. With the jealousy of a collector the Cardinal guarded his treasure trove from the public gaze, admitting but few into his new-found mine, but amongst those whom he did admit were Raffael and his assistant, Giovanni da Udine. The admiration of these two artists was so greatly excited by what they saw that they accorded to it the sincerest flattery, that of imitation, and Giovanni, struck by the stucco work, the like of which he had never before seen, set to work and strove to reproduce it. His struggles to revive the old composition were, after many experiments, crowned by success, for whether by intuition or by reading, or by the survival of tradition, he at last hit upon the composition given by Vitruvius—white lime mixed with marble dust, and announced that he had rediscovered *il vero stucco antico*. Raffael was so pleased with this result, that he placed the ornamental details of the decoration of the Loggie of the Vatican in Giovanni's care, the Loggie being the first work the Cardinal commissioned him to execute after his own election to the Papal Chair under the title of Leo X. in 1513.

Not that working in stucco was then unknown. It seems to have been practised at all times when art was cared for; but the secret of the old white stucco duro had been lost, and stucco was, therefore, relegated to less important sculptural works. As such it had long been used by the artists of Florence. Donatello, who lived between 1383 and 1466, practised it frequently, making many experiments in composition, using pounded brick and glue with his stucco, achieving a result so like terra cotta (without the risk of firing), that some of his stucchi now pass as terra cottas. There is a group of the "Entombment" over the door of the Sacristy of St. Antonio of Padua, called a terra cotta, but which, I am informed, is really a stucco. It is inlaid with *plaques* of marble and *tessere* in mosaic, additions easily pushed into stucco, but not so easily fitted into terra-cotta; and it

is extremely probable that more careful examination would prove many other of his so-called *terra cotta* to be *stucchi*. In acknowledged stucco are four medallions by him of the evangelists in the Sacristy of San Lorenzo, in Florence, of which you will find photographs on the walls. There is, in the South Kensington Museum, a large *plaque* of stucco attributed to him, of a Virgin and Child, but to which I am inclined to give an earlier date and class it as a work of the Pisan school, quite early in the 15th century. In the Old Masters Exhibition of 1888 (No. 21), we had a fine coloured stucco of the same subject by Donatello, and many similar ones attributed to him exist in continental collections. There was also there another of the Holy Family (No. 5), a *replica* of the marble bas-relief at St. Petersburg, and several other 15th century *stucchi* which I daresay live in the memory of those of you who care for these things. Most of these were highly coloured, for almost all sculptures at that date were so treated; and you will find in the South Kensington Museum many which yet retain their painted decoration; but alas! more have suffered from the hands of the scraper at the time when it was supposed painting applied to sculpture was a barbarism and a heresy.* One very interesting *plaque* in the South Kensington Museum exhibits the evidence of the lingering of the Gothic feeling. This, a relief of the Virgin and Child seated under a canopy and surrounded by angels, whilst the Eternal Father gives his blessing from above; the frame is panelled with tracery work, of late 14th century character, and it is probably earlier than the date 1430 attributed to it; and there are many others in the Museum which I advise the student to carefully study. One of these *bassi-relievi*, with its coloured and gilded decoration, I am enabled to show you here this evening. It is a cast from a marble, probably by Rossellini, and is of the most tender and beautiful character. It is true it is not in stucco, but in plaster; but in all other respect is a charming representative of this very beautiful phase of plastic art.

It was evidently a custom of the sculptors of the 15th century to publish replicas of their works thus decorated, and amongst the *stucchi* and *gessi* remaining to us, we no doubt have records of works in marble now lost.

* An exceeding useful and learned monograph on "La Polychromie dans la Statuaire du Moyen Age et de la Renaissance," in which these coloured *stucchi* are referred to, was published by M. Louis Courajod, Professor of Sculpture, at the Louvre. (Paris, 1888.)

Again, it was much used by artists for modelling the first studies for works intended to be executed in marble, bronze, or other materials; and in South Kensington Museum you will find studies in stucco by Della Robbia and Gian. Bologna. Benvenuto Cellini tells us that he modelled his celebrated "morse," or cope-clasp, for Pope Clement VII.—an elaborate piece of goldsmith's work—in white stucco on a piece of slate. It was "as big as a little trencher." A figure of the Eternal Father occupied the centre, under whose flowing mantle the hierarchy of heaven crowded. So you see stucco could be worked to the highest degree of finish, and on the smallest scale.

These *stucchi* were all portative decorations, intended chiefly as shrines for house altars or private oratories, and are all in grey stucco, coloured, or had been coloured, and were executed before Giovanni had revived the white stucco *duro* of classic times. What this grey stucco was composed of we learn from a receipt given in the Marciana MS.—the which, as giving us both the earlier and later composition, is doubly interesting. It is described as having been "tried by Master Jacopo di Monte S. Savino, the sculptor," thus, "Admirable stucco for making and modelling figures and for colouring them, and it resists water."

"Take of finely powdered travertino lb v, and if you would have it finer and more delicate, take fine marble instead of travertino, and lb ii of slaked lime mix them together with water, and stir and beat them together like a fine paste, and execute what you please with it, either by forming it with your hands, or in moulds, and dry it in the shade. And if you wish to colour it white, when the work is dry enough to be tolerably firm, but not quite dry, grind white lead with water, in the same way as colours are ground, and flour of sifted lime, and apply it with a pencil, and it will be very white, and effectually resist water. And if you wish to colour it with other colours, let the work be perfectly dry, and then colour it; but these colours will not resist the water like the white, because they do not incorporate so well with the material of which the work is composed. If, then, you wish the colours to resist water, apply on the above-mentioned composition (which is to be used in the manner described), and paint it with oil colours. You may also colour the stucco with colours ground up dry, but these will not be so bright as if they were applied afterwards."—Mrs. Merrifield, "Ancient Art of Painting," vol. ii., p. 638.

It must not be supposed that these *plaques* were always of religious subjects, as we have

many records of mythological and domestic scenes, and portraits modelled in relief; but the greater care and veneration shown to the former was not always bestowed upon these. Their allusions passed away, the personages forgotten, and they became neglected and destroyed.* Nor were reliefs alone done in stucco. There is in the South Kensington Museum (7628) a portrait bust to the hips, modelled entirely in the round; and Alfonso Lombardi, who made many portrait medallions—amongst others, that of the Emperor Charles V. (modelled from the life, whilst Titian painted his portrait at Bologna)—also executed a large group in the round of the “Death of the Virgin” (1559), *de mistura e di stucco molto forte*, still existing in the Church of Sta. Maria della Vita, at Bologna, which so won the admiration of Michael Angelo, that he exclaimed, “Si questa terra diventano marmore guai alle statue antiche.” There is also, by him, a large group of “Hercules and Hydra,” modelled in the round, in the Palazzo Publico of the same city. Many other stucco statues of his exist, for notwithstanding that he wrought ably both in marble and in bronze, he seemed to prefer the more rapid result attained by stucco, and as says Vasari, “esercito l’arte più per piacere e per una certa vanagloria.”

All these were executed in the grey stucco, and were in all probability coloured, or at least whitened, as Sansovino prescribes. There was also an architectonic employment of this grey stucco, used for external work. Torregiano did some at the Torre del Borgia, just before he broke Michael Angelo’s nose, and fled to England; but Bramante (1444-1514) is described by Vasari as being the inventor of this application, using “una mistura de calce” for his friezes and foliage; and we know from designs still existing that the house he built in 1513 for his nephew Raffael da Urbino was decorated with garlands and medallions of stucco work in high relief, then considered “una cosa molto bello ed invenzione nuovo,” so that may serve as an available date for its external use. Raffael’s house stood in the way of the great colonade in front of S. Peter’s at Rome, and was for this reason pulled down in 1616. Indeed, the enormous amount of decorative work which had to be done at the

commencement of the sixteenth century demanded some speedy means of execution, and the revival of stucco was the consequence; but the great impetus given to stucco by Giovanni’s re-discovery of the hard white stucco (“stucco duro” as it was thenceforth called), and its use in the Vatican was really the commencement of the new history of this re-invented art for internal decoration. The Loggia formed its cradle, Leo X. and Raffael were its sponsors. With this distinguished introduction into the art-world it had an easy career marked out for it, and its course was smooth as it was long. All the artists engaged at the Vatican looked kindly upon it. Giovanni da Udine worked from 1514 to 1519 at the Vatican as Raffael’s superintendent of stucco moulding and arabesque painting, or, as it was then called grottesque painting, having had its revival from those exhumations from the underground *grotte* of which I have before spoken. These, the façade of the Palazzo dell’Aquila, the Farnesina, and all the other decorative works where Raffael as architect was engaged, occupied him until the death of his master on April 5, 1520. A glimpse of what Giovanni’s work at the Loggia of the Vatican was will be caught from the engravings of Volpato from which two groups of pilasters hang on the wall. These are in groups of three, the centre one being painted, whilst the two lateral ones are filled with stucco-duro medallions in relief; some very hurriedly and surreptitiously taken casts of these latter exist in the South Kensington Museum, useful only as a matter of scale, but do not show the beauty and delicacy of the work. In one of these groups shown on the wall, the painted panel is by Giovanni da Udine; so painting and stucco work are both his. In the other, the painting is by Pierino del Vaga. Of these groups of pilasters there are no less than twenty-six, containing about five hundred different stucchi painted as camei, or relieved with gilding, and as the vaultings which unite these are often embellished with similar reliefs, frequently on a much larger scale, some idea of the magnitude of Giovanni’s work in this first attempt to revive the lost art may be formed. The designs for these were in some instances taken from the old examples in the Golden House of Nero, sometimes from Raffael’s own work, as witness the expulsion of Adam and Eve in the engraving shown, but generally from designs by Giovanni da Udine.

On the death of Raffael, in 1520, Giulio Romano, to whom, with Penni, he bequeathed

* There is in the South Kensington Museum an interesting male head, placed in shell-formed disc, evidently taken from a cast after death, the female companion head is in the Louvre, and an engraving of it, together with much interesting information on these mortuary stucchi, will be found in M. Louis Courajod’s “Sculpture Funéraire,” Paris, 1882.

his post as chief decorator and architect, carried out the works the great master had begun, and amongst them was the Loggia della Vigna, now called the Villa Madama, designed by Raffael for Cardinal Giulio di Medici, who was a cousin of Leo X., and who afterwards became Pope Clement VII. in 1523. With touching fidelity Giovanni stuck to his work, and allied himself with Giulio Romano to carry it out. I cannot do better than refer you to the model of it now in the South Kensington Museum, where you will see, admirably reproduced on a small scale, by Cav. Mariani, the beautiful stucco work of Giovanni at the Villa. He missed, however, the gentle manners of his first master and friend, and though he remained loyal to his task, there does not seem to have been any great accord between Giulio and himself, for on the death of Leo X., Giulio Romano having finished the Constantine pictures in the Vatican, left Rome, and went to Mantua, where I shall have to leave him for a time.

By the the time Giovanni had his work finished came the troubles which ended in the sack of Rome by the French in 1527, when all the artists gathered there were dispersed. Giovanni then went to Florence, where he wrought in stucco for Cosimo di Medici. Thence to Venice, where, in 1539, he was at work for one of the Grimani, a family which had given him his first lift in life, and afterwards we find him doing stucco work in his native country of Udine, adorning with his art the chapel of Madonna del Monte, near Civitale. Ultimately, under the papacy of Pius IV., he, solitary, unknown, and in the guise of a pilgrim, returned to Rome, where he was discovered by Georgio Vasari, who brought him to the feet of the Pope. Pius IV. received him graciously, settled a pension of 300 scudi upon him, employing him on the third or upper Loggia of the Vatican, and in repairing the damage done during the troublous days that had passed between his flight from and return to Rome to his first work on the second Loggia. He died in 1561, and was buried in the Pantheon, hard by the tomb of his master, Raffael, whom he had so faithfully served and so fondly loved. Thus lived and died Giovanni da Udine, the first reviver of the art of working in stucco duro.

An art so easily applied, patronised by Popes, and lauded and practised by the foremost artists of the day, naturally became immensely popular; hardly a new building in Rome lacked it; and it was gradually making its

way outside it, when came the sack of Rome, and the consequent dispersion of the Papal Court and its artists. These latter, seeking refuge elsewhere, carried the art of working in stucco with them. Pierino del Vaga (1500—1547), who had risen from the lowest step of the ladder of life to become one of Raffael's esteemed assistants, and who, whilst one of the foremost painters of that brilliant company the master gathered round him, was also, says Vasari, "*negli stucchi non solo paragonè gli antechi ma tutti gli artefice moderni*," fled to Genoa, where his reputation was so great that the Prince Doria lodged him in a palace, and he was soon engaged in working in stucco on friezes and ceilings, and raising up a school of stuccatore in the city of palaces, until the restoration of Clement VII. The school remained and prospered; but he again returned to Rome, and there again, in the Sala Regia and other rooms in the Vatican, worked both in painting and in stucco. Many other of the artists dispersed by the sack of Rome returned, like Pierino, and in a short time no building was deemed completed until the stucco worker had imparted his finishing touches to it. I must not pursue its course, but content myself with giving you an illustration of one of the ceilings to the staircase of the Palazzo Mattei (di Giove), executed by Giulio Mazzoni, from the designs of Carlo Maderno, in 1615. Many other palaces in Rome are built and decorated by them, and the Mazzoni family boast a long line of eminent *stuccatori*.

Jacopo Sansovino, who was equally distinguished both as an architect and as a sculptor, fled to Venice, where he fostered the new art, ultimately raising there a school (which even yet exists)*, strengthened by his pupil, Alessandro Vittorio (1525—1608), a versatile and prolific sculptor and decorative artist, to whom nothing artistic came amiss, albeit that he is accused by a modern writer† as "having spent many years of his life, which he should have devoted to severe study, in modelling ornaments for public and private buildings in stucco." What those ornaments were, you will see in the photographs of the Scala d'Oro

* Cav. M. Guggenheim, who has had much stucco work done in the Palazzo Papadopoli, and elsewhere, sends me the formula for the stucco duro still used in Venice. It is old stone-lime, slacked for three years at least, mixed with Carrara marble dust, ground as fine as flour, into the consistency of paste. This, of course, is for the finishing coat, the rough modelling being executed with a coarser material.

† C. C. Perkins. Moulage en Plâtre chez les Anciens. Paris, 1869.

and the Camera de Quattro Porte in the ducal palace, and the Palazzo d'Albrizzi, and in many of his other works, in marble as well as in stucco, which earned for him the title of the Michael Angelo of Venice. A portion of his work at the Albrizzi I can show you enlarged, and you will find on the walls others illustrating his somewhat fantastic power, as also his more restrained efforts in the Ducal palace.

Vittoria's style is too exuberant and not always commendable, but his power as a modeller, and his skill as a stucco worker, is beyond all praise, demonstrating the great capabilities of this valuable material. Florence, to which, as I have said, Giovanni da Udine carried the art, and where Vasari fostered it, found in stucco the new spring of an old cultivation, and in the ceilings of the Pitti, where much wondrous work was done, to a portion of which I now draw your attention. (This, and the other ceilings of which you will find illustration in the photographs, were done about 1530, but I do not know the names of the artists). In the Cortile of the Palazzo Vecchio, you will see somewhat of the crop the new-sown seed produced. This picturesque bit of 16th century work is notable as showing how well stucco will stand, even in situations exposed to rough usage, for this enlarged detail of one of the piers will prove to you how little abrasion it exhibits after more than 300 years of usage; you will find on the walls photographs of all the other piers, which are in equally good condition. The names of the *stuccatore* who did them are recorded, they are Pietro Paulo Minocci, da Forlì, Lionardo Ricciarelli, da Volterra (of whom we shall hear again), Sebastiano Tadda, da Fiesoli, and Leonardo Marignolli, da Ferrara. In this last city there is, in the absis of the cathedral, a fine frieze. In Parma, also, much stucco exists; and, in short, every city in Italy, strove in rivalry to foster the new art of the *stuccatore*. Giulio Romano, urged by Count Baldassare Castiglione, accepted the invitation of Frederic Gonzaga, the Duke of Mantua, and went there in 1524, as I have already said, to construct and decorate with painting and stucco that glorious assemblage of the Palazzo del T, the Ducal palace, the Giardino Pensile, and a house for himself, in all of which stucco played a prominent part.

It is with Mantua that much of the interest of those who live on this side of the Alps rests, for thence it came to us in this wise. Giulio Romano's work there was in full operation before the sack of Rome took place, and he gathered all the stucco

workers he required from the provinces, the capital yet having need of them. Amongst these recruits was Francesco Primaticcio. Primaticcio was a native of Bologna, of good family, and brought up to be a merchant; but art won him from commerce, and this led him to enrol himself under the banner of Giulio Romano, so he went to Mantua immediately after Romano's arrival, where for six years he wrought under him with much diligence, achieving great repute, both as a colourist and modeller in stucco; so that he, above all the other young men, "fu tenuto dé' migliori e quegli che meglio designasse e colorisse de tutte" (Vasari); and his wonderful friezes in the Camerone Grande, full of figures of Roman soldiers, representing the triumphs of Sigismonde, won for him the especial praise of his master, and the esteem of the Duke. Thus it came about that when Francis I.—whose personal tastes and political aspirations leaned towards Italy, and who was then building Fontainebleau—like all magnates, desiring the new mode, wrote to Gonzaga, asking him for "un giovane il quale sapessa lavorare di pittura e di stucco," Primaticcio was sent to him in 1531 with cordial recommendations. Il Rosso, an Italian painter of some note, and some other Italian artists, had preceded him the year before; but Primaticcio soon became the leader and chief superintendent of the works there, and, says Vasari, "did the first stucchi ever executed in France and also the first frescoes." This is, perhaps, not absolutely the fact, for the Gros Horologe at Rouen has architectural accessories executed in this material about 1529, and the Manoir of Yvillesur-Seine has some, which judging by the Gothic character of its detail, must be even earlier, indeed an early school of stucco workers seems to have been well established in the Valley of the Seine before Primaticcio's advent. Chimney pieces in stucco of very considerable richness are found in the neighbourhood of Toulouse, and in many other parts of France; but Primaticcio was the first to produce works of high artistic value, and his friezes which still exist at Fontainebleau will demonstrate to you how noble these were; but, alas his best work was destroyed in 1738 to make way for some paltry additions. Some views of these friezes you will see in the photographs. You will see by this enlargement on the screen that the stucco work of the gallery of Francis I. forms noble cartouches for the painting and frescoes, and will illustrate how available for the decoration of

public buildings stucco work can be made. He worked at Fontainebleau through the reigns of Francis I., Henry II., Francis II., and Charles IX., dying in Paris in 1570. This long range of 40 years' work, and its varying style, is fairly shown by what yet remains to us there, and its influence on the work of Jean Goujon, Pilon, and the French school of sculpture of the middle 16th century is prominently manifest. This is pre-eminently marked in that large group, where the long graceful figures, with their palpitating flesh, exhibit that *morbidezza* so facile of attainment in stucco, and so difficult of attainment by other processes. The third illustration of Primaticcio's work illustrates his latest phase, showing how receptive he was of the artistic movement of the time. He never crystallised but was ever fluent, and an examination of the other photographs will prove to you his power and genius as a stucco worker. Primaticcio's work was not, however, confined to Fontainebleau, the Chateau de Meudon for Cardinal de Lorraine and other noble buildings in France were filled with it.

I have dwelt somewhat lengthily on these works of Primaticcio at Fontainebleau, because they have a very important influence on our own country, for Henry VIII., in all things the rival of Francis I., would not be willingly behind him in introducing the new art into his own country. He therefore determined to provide a palace for it which should out-do everything that had preceded it, and commenced to build the now vanished Nonesuch, on the hills between Cheam and Epsom, and within easy reach of Hampton-court. To this end "he procured many artificers, architects, sculptors, and statuaries, Italian, French, and Dutch, as well as natives, who applied to the ornament of the mansion the finest and most curious skill they possessed in their arts." (Braun, "*Civitates Orbis Terrarum*.") Built according to a then custom of our country, of timber framework, having large panelled surfaces of plaster, it was pre-eminently fitted to display the stucco worker's art. What this art was we must construct from what knowledge we can glean of the men who did it, and from the description of those who saw it. Amongst the most notable of the Italian artists who thus came were Nicolas of Modena, a "keruer" and modeller, who had been working with Primaticcio at Fontainebleau in 1533. Luca and Bartolomeo Penni, brothers of the celebrated Giovanni Francesco Penni, who, from his ability and rapidity, was known as *Il Fattore*, of whom Raffael thought so highly

that he left him co-heir with Guilio Romano of his unfinished works. Luca probably did not stay long in England, but joined Primaticcio at Fontainebleau, ultimately returning to Italy, where he died. Of Bartolomeo little is known, beyond the fact that payments were made to him in 1538 and 1539. Girolamo de Trevisa, or "Jerome of Trevisa," as he is known in the English account books, was a painter from Bologna, where he did much work, but, coming to England, he entered the service of Henry VIII., "non piu pittore ma per ingegnere," for fortification was a favourite study of the 16th century painters. But Vasari also tells us that he "made many ingenious edifices, and one honourable house for the king's use;" so that he was possibly engaged on the new palace, though the arrangement and construction was decidedly English in character. He was killed at the siege of Boulogne 1544, whilst acting in his capacity of a military engineer. John of Padua, probably an architect, and certainly a learned musician, was, on the death of of Trevisa, appointed "Devizor of his majesty's buildings," though what he did is somewhat obscure.

And then there was Toto del Nunziata, called in our records Anthony Toto, to whom may most probably be assigned the direction of the stucco work which rendered Nonesuch pre-eminently famous. Toto was a fellow pupil with Pierino del Vaga in the studio of a very moderate Florentine painter, who was more engaged in modelling ex-votos and religious images in coloured wax than in painting, and who thus acquired the cognomen of Andrea de Cera. Cera brought both Pierino and Toto to Rome with him, where Pierino, as I have shown, stayed until 1527 working equally in stucco and in painting, and who, both at Genoa and on his return to Rome still wrought as a stucco worker. Toto appears to have returned with Cera to Florence, where Vasari tells us he was considered "by the youth of his time as a paragon," but, being involved in some serious quarrels, "he left Florence with sundry merchants, who carried him off to England, where he made all manner of works for the king of that country in architecture, and particularly the principal palace." Now, Nonesuch, the principal palace building at that time, was begun in 1538, and in 1539, Toto was appointed "Sergeant-painter" to the king, the term painter then embracing all artistic pursuits; even Torregiano, in some documents at the time, is so styled. Seeing then, how the

education of his fellow pupil Perino, led to his combining stucco work with painting, it is fairly presumable that such had the like influence on Toto. Of his work in England we know very little, in spite of the many payments made to him, so I think that with the disappearance of Nonesuch his chief work disappeared also. What that work was we can only learn from casual describers. We have a general view of the building—a very sumptuous pile, engraved by Haefnagel in 1582, and a small portion of it in the corner of Speed's map of Surrey, engraved in 1610, in both of which the position and some faint indication of the stucco work is given, but the written description of it by visitors is more elucidatory. The first of these I have found is Hentzner, a German traveller, who, in 1598, says, "One would imagine everything that architecture could perform to have been employed on this work. There are everywhere statues that seem to breathe, so many casts that rival even the perfection of Roman antiquity, that it may well claim and justify its name Nonesuch, being without an equal." The Duke of Saxe-Weimer, who went there in 1613, tells us that "The labours of Hercules were set forth on the king's side, the queen's side exhibiting all kinds of heathen stories with naked female figures." We have no other description of the stucco until Pepys's time, when he saw it after the decay and destruction which fell upon it during the Parliamentary Wars, and when in 1665 the Great Plague drove the Exchequer there to seek a healthful refuge in its ruins, he describes "All the house on the outside as being filled with figures of stories and good paintings of Rubens' or Holbein's doing, and one great thing is that most of the house is covered—I mean the posts and quarters of the walls—with lead gilded." Pepys was not much of an art critic, but his comment is valuable to us, as shewing that these stucchi were coloured like their early predecessors. The year after Pepys's visit John Evelyn was then driven to it, this time by the Great Fire. He, a much more educated and observant man, says, "I took an exact view of the plaster statues and *bas-relievs* inserted between the puncheons of the outside walls of the court, which must have been the work of some celebrated Italian. I much admired how it had lasted so well and entire from the time of Henry VIII, exposed as they are to the air, and pity it is they are not taken out and placed in some dry place—a gallery would much become them. They are *mezzo-relievs* the

size of life. The story is of Heathen Gods, emblems and compartments." Pity indeed it is that John Evelyn's suggestion was not carried out, and then, perhaps, we should have some relic of this first introduction of artistic stucco duro into England extant, but if you regard the contemporary work done by Primaticcio and his school at Fontainebleau, you can, with the light thrown on it by various visitors, form some tangible idea of the glory of this vanished palace. Henry VIII. died in 1547, before it was finished, but it was saved from dilapidation and destruction by Henry, Earl of Arundel, the king's art-director, and the instigator of this work, who purchased it from Queen Mary, and who "for the love he bare to his olde maister . . . did not leave till he had fully fynished it." There is but little doubt that he added Hans Holbein to the list of artists engaged on this sumptuous building, as it was through him that Holbein came to this country, and in the British Museum is a drawing, with Holbein's name, of a design for a chimney-piece, bearing the king's monogram and device, with the not inappropriate subject of Esther and Ahasuerus in the centre. Nonesuch reverted to the Crown on the earl's death, and Elizabeth frequently visited it, and Haefnagel's print shows us one such visit. Under James it was little visited. In Charles I.'s time it was neglected; sacked and pillaged in Cromwellian days; given away to a harlot by Charles II., sold by her piecemeal; and even yet, in James II.'s time, enough remained to be still noteworthy, for a MS. note by P. le Neve, Norroy king-at-arms, in his copy of Aubrey's Surrey, says he then saw it, and that it was "done with plaster work made of rye dough very costly;" and that is the last we hear of this Royal monument which introduced decoration in stucco work into England. This admixture of some glutinous substance, referred to in the tradition preserved by Le Neve, is noteworthy. I have tried it, and it makes an excellent compound for modelling in; it retains its pliancy long, dries hard, and is of a beautiful old-ivory tone. Although neither Vitruvius nor the Italian receipts in the Renaissance period I have quoted allude to it in any way, yet Pliny mentions fig juice, a very viscid sap, as being mixed with the stucco of his day. Justinian's Church of the Baptist in Constantinople had stucco mixed with elm bark and hot barley water, that is tannin and size. White of eggs and blood are also mentioned by him as being so used; and the practice of some such ad-

mixture was common in England from very early times. Bullock's blood was used in the mortar and stucco of Rochester Cathedral at the end of the 9th century. At Rockingham Castle, in 1280, melted wax was used; and Queen Eleanor's Cross at Charing-cross, c. 1300, had white of eggs and strongest wort of malt mixed with its lime and Calais sand. In Edward II.'s works at Westminster (1324-7) pitch was mixed with it, and wax and pitch at that time were largely used for this purpose. In 1571, the accounts for the repair of the steeple of Newark church contain an entry, "6 strike of malt to make mortar to blend with ye lyme and temper the same, and 350 eggs to mix with it;" this was to seven quarters of lime.* M. A. Darcel, the director of the Musée Cluny, tells me that urine was used at Rouen and in the valley of the Seine in the early part of the 16th century, and I have no doubt an inquiry into the local tradition of many places would give further information as to these usages. In Ceylon and India, sugar and the saccharine juices of fruit, the gluten of rice, and other similar compounds, are used for the hard white *chunam*, and research in this direction would largely add to our knowledge. All of these recipes are for increasing the hardness of the composition, whilst others not only have this end in view, but also seem to delay the setting process, and allow more time for its manipulation.

After this technical digression, I must return to the progress of the art of stucco working in England. The royal patronage the craft received induced many to study it, and our native workmen received it gladly, treating it in a truly native manner; for notwithstanding that it was at first practised almost exclusively by Italians, who came over to assist those who had commenced the work at Nonesuch, an entirely English system prevailed. Of the Italians who thus came, between the date of Henry's death and 1600, I find the names of De Rudofi, in 1550; G. Nanni, in 1564; Lionardo Ricciarelli, in 1570 (he was one of those who did some of the beautiful work I have shown you in the *cortile* of the Palazzo Vecchio, at Florence); and Luca Romano, in 1586, who had been assisting Primaticcio at Fontainebleau. But where these were engaged, or on what, other than Nonesuch, I have found no trace; possibly religious prejudice and

lingual difficulties prevented their employment away from their fellows there.

In the reign of Edward VI., the English plasterer had rapidly learned the art, and in what esteem he was then held is shown by the fact that his wage was 11d. per day, whilst painters only earned 7d. and 6d. Our English stucco workers were then largely occupied, and almost every house of importance, erected during the reigns of Elizabeth and James I., was adorned either internally or externally, and often both, with their work. Not educated to the highest branch of the plastic art, these generally avoided figure work, and took refuge in geometric pattern. Nor was this without other reason, for the lowness of our rooms required a less ambitious treatment than did the lofty *salons* of France and Italy. The fan tracery of the late Gothic of Henry VII.'s time afforded them an excellent starting point, and its radiating ribs and pendentives, such as you see at King's College, Cambridge, Oxford Cathedral, Henry VIII.'s Chapel, and in much other "perpendicular" vaulting, offered an excellent suggestion. It readily lent itself to the subdivision of the ceiling into squares of moderate magnitude, as in the "Watching Chamber" at Hampton Court, Red Lodge-park, Bristol; Stockton, Wilts; Crewe, and all over the country; and not even when the rooms were ceiled between the main beams, in order to gain height, did this trabeation prevent the adoption of this quasi-Gothic treatment, as you will see by the photograph of the Nelson-room, in what is now the Star Hotel, at Yarmouth, which was executed about the latter end of the reign of Queen Elizabeth, this room then being the principal one of a wealthy burgess of the town.

This pendentive system outlived the radial tracery form, from which it sprang, though the radial root form often exists on pendants, even when there are no co-relative ribs on the ceiling. The geometric arrangement of the ribs soon became infinite: interlacing quatrefoils, squares, lozenges, and circles abounded, many of the arrangements being equally beautiful and ingenious; but rarely were large figure subjects introduced amongst them, small emblems, armorial bearings, and personal devices being used to fill up the voids of the geometric pattern. Gradually, the size of the subdivisions increased, until it became the practice to divide the rooms into four quarters, and, no matter what their size, unless they were long galleries and corridors, the patterns

* For these recipes, and for other information on the composition of old stucco, I am indebted to Professor J. H. Middleton.

occupied a quarter of that space, reversed; this made half the room, and that half doubled completed the design. The enlarged cartoon thus obtained led to the abandonment of merely geometric pattern, and soon lines of wondrous device took possession of the ceiling—involuted, contorted, with quaint unexpected quips and cranks—a true parallel, in fact, to the quaintly involved literary diction of the time.

In the earlier ceilings these ribs were plainly moulded after the manner of groin ribs. As the power of execution grew, they had flat surfaces often ornamented by impressed ornament, run on by a revolving stamp like a book-binder's tool, with here and there a bossage of higher relief from a wooden matrix, fashioned like a butter stamp. These ribs have moulded edge and handwrought bosses at their junction, producing an exceedingly rich effect.

It would be beyond the already extended limits of this paper to attempt to follow this ramification of design throughout all its branchings; but it may be well to inquire somewhat as to the designers of these ceilings. It has been suggested that they are borrowed from German and Dutch sources, such as Virgil Solis (1514–63), Vredman de Vriese (1527–60), Wendel Dieterlin (1594–96), and the other engravers and designers of the Continent, but I do not find any evidence of plagiarism, and there are radical differences between the Renaissance of England and that of other countries sufficiently marked to enable us to distinguish them. Again, plastered ceilings were not common in the countries whence these designs came, wooden ones being chiefly in use there. I think, therefore, that our master workmen had their own album of designs, and travelled about the country with them, frequently repeating them. They do not seem to have often published books of designs in this country at that date, though in 1615, Walter Geddes published "*Sundry Draughtes, principally serving for Glaziers and not impertinent for Plasterers*," giving outline diagrams of geometric forms; but beyond one or two of the most obvious ones, I cannot trace anything identical in the executed plaster work. If the character of our ceilings had resembled those of other countries, they would not have so excited the admiration of foreign visitors. The Duke of Wurtemberg, who visited England in 1598, expresses himself astonished at their richness and beauty; but it must be remembered that they were not white, as they generally now are, but the plasterer and the

painter were the same, and colour and gilding played a large part in their decoration.

"Gold was the parget, and the cieling bright,
Did shine all scaly with great plates of gold,"

says Edmund Spenser; and Sir Henry Wotton, King James's ambassador to Venice, where stucco work, as I have already told you, abounded, whilst recognising the good use we made of it in our ceilings, urges us to make larger use of it for figures, for "*Plastique art*," says he, "is not under sculpture, but very sculpture itself, but with this difference that the plasterer doth make his figures by addition and the carver by subtraction," quoting the Italian use of it for "*mantling of chimneys with great figures*." Of such stucco mantels we have some examples in England, but it chiefly maintained its sway on our ceilings, with frequent external pargetry between the timber framework. Much of this has disappeared; but at Maidstone, Ipswich, Tewkesbury, Ludlow, and in some of our quieter old towns, there still remains enough to show us how general was its use.

I do not think that I can give you a better idea of the state of the stuccoer's art in the middle of King James's reign, than by giving you some illustrations of one house, Audley-end, from which Lord Braybrooke has kindly permitted me to have photographs taken for this purpose. Built for Thomas Howard, Earl of Suffolk, King James's Lord Treasurer, between 1603 and 1616, it still is a very noble specimen of the architecture of the time, although the huge forecourt, which occupied as much ground as does the existing house, is destroyed. It is stated to have been designed by Bernardo Jansen, a Dutchman, probably a relative of Cornelius Jansen, the painter, but who was, perhaps, only the modeller and carver, as he was intimately allied with Nicholas Stone, our chief English sculptor of those days, who had received his education and his wife in Holland. Probably most of the ceilings were designed and executed by him; and few houses in England can show so fine a series of the same date, giving us examples of nearly all the systems of design I have referred to. The great hall has medallions in the square portions of the ceiling, formed by its dividing timber beams. The large saloon, on the principal floor—a room about 66 feet long by 30 feet wide—has a very remarkable ceiling of the pendentive type, which presents many peculiarities, the most notable of which, that these not only depend from the ceiling, but the outside ones spring

from the walls in a natural and structural manner. This is a most unusual circumstance in the stucco work of the time, the reason for the omission of this reasonable treatment evidently being the unwillingness of the stuccoer to omit his elaborate frieze, in which he took much delight. These friezes were often very large. Some at Crewe-hall are nearly 6 feet deep, ornamented with medallions of the "Virtues," in bold cartouches, united by floral and strap ornament. At Montacute the frieze is adorned with the armorial bearings of the neighbouring families, bearing out the graceful dedicatory welcome over the entrance, "To you, my friends." Here, at Audley, the frieze is bald, and wanting in sentiment, but it reveals the pride of the designer in a peculiar manner.

You will see by the dimensions that it was not easy to divide 66×30 into equal squares. There are 32 truly square subdivisions of the ceiling, from the angles of which depend square pendants, whence issue margining ribs curving outward, and having a central swell. It was on this swell the designer relied for making up his missing dimension; so in the longitudinal ones he placed a quatrefoil, and in the transverse ones a bifoil, thus obtaining his desired aim, and so pleased with his ingenious device was he, that he placed it, "writ large," on the frieze. He would have done better to have hidden his secret more discreetly, and many better means of filling up his frieze could have been adopted.

Returning to these pendants, their connecting ribs are filled with the most delicate foliated ornament, partly cast, but eked out with carefully modelled work where required. The compartments between these are filled with a modelled panel, each one bearing some aquatic subject, which gives the name of the "Fish Room" to this apartment. Each panel differs from the other; there are ducks and swans, mermaids and mermen, fishes natural and supernatural, monsters from the vasty deep, ships and boats, things that were and never were on the face or under the surface of the water; and it is very curious to compare these with the cuts which appear in seas and rivers in Drayton's "Poly-olbion," which, dedicated to "Henrie, Prince of Wales," was published in 1613, whilst this work was being done. It was, therefore, a possible courtier-like attention to the then "hopeful Heyre of the Kingdoms of this Great Britain" which suggested this strange

decoration, heirs apparent and treasurers having much connection with each other.

The long corridor has a recurrent pattern of ingenious composition, and the other rooms are quartered as to their arrangement of pattern. The boudoir is a very good specimen of this class of ceiling, the ribs having a moderate projection, filled in on their flat with carefully designed groups of fruit, which are cast or impressed, the foliage intervening being hand-wrought, to suit the varying lengths and curved surfaces.

Lord Braybrooke's study is a large room, about 40×24 , and presents a fine example of the quartered arrangement, for although by the disposition of the pendants it would appear to be divided into 36 compartments, yet the design of the ground work divides itself into four only. Each cartoon for the ornament being 20 feet long by 12 feet wide, and within these dimensions the convoluted band work is of continuous and most ingenious design, being so even in its distribution that it is in no place too open, nor any place overcrowded. The frieze beneath this is composed of a series of very bold and salient cartouches containing heads, repeating the lower one of the two very beautiful stone friezes on the very beautiful porches of the present entrance front, said to be the work of Nicholas Stone, which once gave upon the huge forecourt now removed. This type of convoluted ceiling is one of frequent occurrence, and many fine examples of it exist, a notable one being at Charlton, in Wiltshire, where the cartoon for the gallery ceiling requires to be about 20 feet long before it repeats in reverse. Charlton was another mansion of the Earl of Sussex, and both ceilings, though differing, are evidently by the same artist. But for beauty of line and grace of design, none of these ceilings can compare with that of the large library—a room as large as the "Fish-room," that is to say 66×30 . Here the quartering system again prevails, so that each fourth part of the cartoon is 33 feet long by 15 feet wide. The major form of the broad band which marks the design is that of a long oval, interlacing with other curved lines, and all these long lines are so beautifully drawn, that not a lame or halting one is to be found in this large area. It is certainly a triumphant piece of setting out, and has an air of dignity and richness of very rare quality. The field over which this main form flows is well covered with delicate foliage work, with here and there a winged sprite, such as might have done the bidding of Titania. There is in

all this a wonderful refinement and poetic charm, there is no formal repetition, yet a rhythmic balance is maintained, giving an emphasis and a cadence subtle beyond expression, and I know of no other ceiling of this date so pure and so restrained. The frieze is bold, perhaps a little too much so for the delicacy of the ceiling, but in point of design is in advance of the generality of those of the time.

The bay window which juts out from the side of the room well illustrates the delicacy of the foliage treatment of the main ceiling, and the manner in which it was executed. From a central bouquet of modelled flowers four main stems issue, bearing in their lily-shaped terminals the sprites which decorate the large ceiling. These sprites are cast from two of such, and the remainder of the surface is covered with freely-modelled small foliage, evidently done without any cartoon, but nevertheless most carefully distributed. We learn from this that it was the figure work that the stucco-worker then tried to avoid. Having a model for it he cast it, and repeated it; but in the foliage work he felt himself fancy-free, and at his ease. There is another lesson to be learned in the dining-room, once two rooms, or designed for such. The design of one of these ceilings follows that of one portion of the ceiling of the library, for as that cartoon was so difficult to do, and so very good when it was done, the stucco-worker could not refrain from re-using it. The main form was evidently the first thought with him; of the minor detail he thought but little—that came to him by instinct—and here he varies all the foliage which trails about the field so widely from that of the ceiling the cartoon was borrowed from, that there is no attempt made, because no need was felt, to copy.

The frieze to this portion of the drawing-room is a very interesting one, containing some well-modelled medallion heads, surrounded by festoons and strap-work, held up by standing figures, and is decidedly more German or Dutch than any other work in the house. There are many other notable ceilings at Audley End, and in no other house that I know is there as good an epitome of the stucco-work of the middle of the reign of James I.

Towards the end of the reign of James I. the art was introduced into Scotland, and probably some of the earliest there are the arched and flat ceilings of Cragievar Castle, which was purchased by William Forbes, who had "made

much wealth by trading in Denmark"—the Queen's native country—and who naturally, as a new proprietor, wished to do things in the newest and most costly fashion. This was about 1611, at which date it is evident that this stucco work was deemed a new thing, as it is especially recorded that "he plastered it very curiously." The patterns are quite similar to those in vogue in England, and a well designed ribbed pendentive hangs from the centre of the vault of the principal chamber. As a rule, these pendentives were not so wisely applied, nor so well designed, in Scotland as in England, but it must be remembered that the fan groining whence they sprang had not been in much use in the former country, and that stone pendentives, when used, as at Roslyn, were coarser and less amalgamated with the groin ribs than they were in England. For other illustrations of Scottish plaster work I must refer you to the very excellent work of Messrs. McGibbon and Ross, now publishing, and to some reproductions of the Scottish stucco work made by Mr. Scott Morton, of Edinburgh.

In the early part of Charles I.'s reign the same principle of design continued, but towards the latter part of it the influence of Inigo Jones and Rubens was decidedly detrimental to the stucco workers. The Palladian character of the architecture, and the trabeated and coffered ceilings of the architect, led to the use of cast enrichments of mouldings, and the desire for large spaces for the painter's figures did away with the lesser division of the ceiling, and though the painter on the ceiling imitated stucco work, the stucco worker himself was banished. Then came the troublesome time of the Commonwealth with the Spartan severity of the Puritans, and so both forms of decoration were destroyed, and at the Restoration it was found necessary to import French and Italian plasterers to execute what little was demanded. This, however, was not much, for Verrio and Laguerre held sway, and the stuccoer had only to prepare the ceilings and friezes for the painter. Indeed, had more been needed, it could hardly have been obtained, for, as the stucco worker's art had stagnated during the troublous period, it, like all that stagnates, died. Again, most of those who had any love for art, found themselves on the wrong side in politics, and, either perforce or voluntarily, left the kingdom. When they returned, they brought foreign fashions and foreign fashioners with them. Thus, when Lord Montague rebuilt Montague-house, he

employed Peter Puget, a French architect, to design it, and Monnoyer, the French flower painter, came over to decorate it. Monnoyer not only painted flowers, but modelled them in stucco, and hung festoons and wreaths everywhere and garlanded everything, endeavouring to make his stucco wreaths compete with the carved wooden ones, such as Grinling Gibbons and his followers did so well. These floral decorations held their sway for some time, often surcharged and pretentious, as in the ceiling from Astley-hall, where the amount of labour expended is by no means commensurate with the effect: it partook too much of the technic of the pastrycook and confectioner to have a lasting hold, and was soon followed by a better and purer character, brought in by the Italian stuccatori, who again flocked into England. What that was, the next slide—of Weston-hall—will show you, where you will note that, not only on the ceiling, but on walls, the stucco worker displayed his skill, and stucco once more became a favourite mode of decoration. The pupils and followers of Sir Christopher Wren adopted it; and in most of the houses and public buildings erected in the first half of the last century you will find very excellent work. The ceiling of the oak-room in the office of the New River Company is an excellent example, and Gibbs's work abounds with the labours of Artari and Baggetti, whom he considered to have been "the best fret workers that ever came into England." You can see some of their work in the church of St. Martin-in-the-Fields. The long foliated character of ornament, erroneously called of the Chippendale style, followed this—a weak travesty of the French ornament of the time of Louis XV., but frequently of beautiful workmanship, and of which there is so much remaining that it must be familiar to most of you. To this succeeded the ruined Classic mode, in which the expiring efforts of the stucco worker exhausted themselves. Of this I, by the kindness of Mr. Brunton, of the Plastic Decoration Company, am able to show you an interesting example, done at Montague-house when it became the British Museum. During the latter half of the last century most excellent work was done in Ireland by the brothers Thomas and Charles Clarke, better work even than was being done at the same time in England. But the extinguishing blow was given by the brothers Adam, who, though elegant and graceful in the general design of their applied ornament, yet by introducing their ready-made cast "composition"

ornament, made by the mile, without a thought in a yard of it, removed whatever desire there might exist for the revival of a noble art so miserably emasculated. Thus expired the art and craft of the modeller in stucco.

Why, then, seek to revive it? you perhaps may ask. My answer in the first place is *Circumspice*. Look around at this small selection of photographs of work that has been done. Why *not* seek to revive an art that did such work as these set forth? It has many advantages, it is free, it is individual, it causes the artist to think long but work quickly. It is not difficult to do. Ah! there is its bane, there lies the cause of all its failure, for if you will reflect upon this brief, but perhaps too long, sketch of its changeful history, you will have noticed that its frequent revival has always been by the hands of men who were great artists, and who sought and found in it a ready means of expressing their ideas—its rapidity of execution was easily acquired by men who had no ideas to express and were not even small artists. It was from the work of such as these "stucco" became a bye-word and a reproach. In every country where it has been practised it was first patronised by Popes, emperors, kings, and learned potentates, was practised by great and honoured artists, and after a while it sank through the inefficient labours of men, who did not learn to use it well or wisely, into being a thing of scorn. Hardly a country where it has lived has not found in it some words to curse by, derived from this abuse and misuse of stucco. In Italian there are words implying disgust, annoyance, nausea, and many others, all based on stucco. In French *stuc* implies grossness, pretentious sham, elaborate nonsense, and other false and odious things; and in our own tongue a "neat stucco villa" is hardly a commendable comment on a house or its holder. This lesson I would point out to all who wish to aid the re-creation of the great good there is in it. Do not think that because the material is cheap the art should be nasty. Because your material is cheap, is easy to work, you will have the larger opportunity of spreading the lesson you would desire to teach and the thought you would give expression to. If you have no lesson to teach—no thought to express—please do not you touch stucco duro. To the artist who longs for a wide field for his work, who feels that practice in the applied Arts leads to success in greater fields, to him who feels that in following the great men I have mentioned

he treads a worthy path, I say, try stucco duro.

The paper was illustrated by a series of lantern slides thrown on the screen. The slides represented the various changes of style in stucco ornament from the first half of the first century down to the last half of the 18th century, whilst further illustration was afforded by numerous photographs on the walls. The casts lent by the Science and Art Department were from early Roman stucchi, as well as some from the work of Giovanni da Udine; and some actual specimens of old stucco were lent by Messrs. Jackson and Mr. Brunton. Modern examples were contributed by Messrs. Trollope.

DISCUSSION.

Mr. I. HUNTER DONALDSON said everyone must have felt great pleasure in seeing these beautiful photographs, mixed with a sense of humiliation because of our incapacity at present to produce such works in this country. Everyone must regret that so beautiful an art was so little practised, and that slight encouragement was given to it. For such work of the best kind to be produced three things were requisite, time, taste, and money, and unfortunately these three were rarely found in combination. Probably some of the best work in this line had been done by Messrs. Jackson & Sons, of Rathbone-place; but wherever it had been done the conditions were not favourable to the highest expression of such art. Until there arose a higher sense of duty in relation to art generally, and a more intense love of it, especially amongst those able to encourage it, they could never hope to approach in any worthy degree the beautiful works which had been shown. They all regretfully remembered that there was in this country a conspiracy between moisture and dirt, which made all kinds of art difficult, and some impossible; and it was particularly gratifying, therefore, to find that this art was so durable. He had had the privilege of seeing most of the actual works illustrated that evening, but had not realised their great durability. Florence was not always so charming as it usually was when Englishmen visited it. It was exposed to very trying atmospheric conditions; and he was surprised to hear that the beautiful columns they had seen had been so long exposed to the open air. If such lovely work could stand the test of time, when applied to public buildings, there were special reasons why it should be introduced here, at all events in places where it might be somewhat protected. They were much indebted to Mr. Robinson for bringing the matter forward, as a complement to the last two papers in that Section, and on showing how durable works of art might be produced. No doubt many people of wealth would give more liberal encouragement to this art, if they were satisfied of its durability, especially with regard to public and other buildings. This might, at all

events, be more extensively employed internally, and, probably, externally also, under reasonable conditions.

Mr. HUGH STANNUS said he had been much struck by the remarks of Mr. Donaldson on the question of durability, and suggested that the attention of chemists might be invited to the matter. He had often heard of size, glue, and such materials being used in making stucco, but it always appeared to him that they would form an element of danger, for he had known stucco work perish in consequence of glue being used. On the other hand, there was some very fine stucco work at Hardwick-hall, near Chesterfield, not only in the house itself, but also in some roofless ruins alongside, though it was there subject to the severe winters of that part of Derbyshire. If some part of it could be analysed by a competent chemist, who would also examine the interesting recipes Mr. Robinson had given in the paper, it might be of advantage. No doubt Mr. Donaldson had hit on the reason why so many of the moneyed classes who desired to have the charms of art in their dwellings, still had a dread about the want of durability, and if they were satisfied on that point, there might be a great future for stucco. Reference was made to the number of modelling students "turned out" each year in the various schools of art, and he knew of one school where they had the instruction of the best teacher of modelling in England, and where the students, after two years training, were capable of doing any quantity of stucco work required. It happened unfortunately, sometimes, that young men had an ambition to become R.A.'s, and to send sculpture to the Academy, so that sometimes instead of having men who would be an honour to applied art, we had second-rate sculptors. Every art of this nature which gave an outlet for their artistic power, helped to find a honourable vocation for these students; and they must all heartily welcome this paper on a subject which Mr. Robinson had made so entirely his own.

Mr. WYATT PAPWORTH desired to express his warmest personal thanks for the very able historical review of this subject, the difficulties of which he well knew, having some years ago tried to compile one, and he had to give it up. One early period of the use of stucco had hardly been touched upon, viz., that of the very early Greeks. In the temples of Sicily the columns were built of coarse sandstone, and covered with a thin film of stucco, about one-sixteenth or one-eighth of an inch thick, which is still to be found in many instances. In Wren's "Parentalia," which was only published in 1750, Sir Christopher, who died in 1723, records the use of "marble meal as the old, and still, the modern way of stucco work in Italy." This was a curious term, and recalled the phrase quoted from Evelyn of rye-meal. Mr. Robinson had not given much detail as to how the work was done; he (Mr. Papworth) had heard from plasterers that the art work was carried

out by hand, but all the running patterns were made by moulds pressed on the soft material on the ceilings or walls, thus forming the outline. Of course that was a rapid way of getting the work done when there was repetition, and it was then finished by hand. These moulds were often of lead, but sometimes of resin. Not much was known of the artists employed on Wren's buildings, but James Gibbs introduced two Italians, G. Artari and Bagutti, who worked in St. Martin's Church, St. Mary-le-Strand, and some other buildings, and also at Cambridge and Oxford. Artari died in 1769, and that brought the art down to a somewhat modern period. A Wilton also did stucco work about 1750. In the same year at Cambridge, Denstone, of Derbyshire, did a large amount of good work. Then there were Peter Naldoni and Samuel Richter, in 1770, and Thomas and Charles Clarke, in 1783, who had been mentioned, and who he believed were Londoners, though they also worked in Dublin, because they were employed by Sir William Chambers when Somerset-house was built; there was some very fine stucco work in the old Royal Academy rooms which was well deserving attention. Another artist employed by Sir William Chambers on the same building was William Collins, who died about 1793. Another name he might be allowed to mention was that of his own grandfather, John Papworth, who died in 1799, and might be said to have been the last who did stucco work in London, such as this—the ornament in the great Royal Academy room a Somerset-house, and with his eldest son the decorative work at the rebuilding of the chapel at Greenwich Hospital, under James (the Athenian) Stuart, the whole of which fine stucco work was done by the hand *in situ*. There was a curious anecdote with regard to that building; the son was at Greenwich some years afterwards showing the place to a party of friends, and one of the guides informed them that the plasterer who did the ceiling, when lying on his back on the scaffold, tumbled off and was killed. He was very much astonished when his uncle said he was the workman. Some time ago he (Mr. Papworth) came across a very beautiful specimen of plaster work in a church in the City, but was unable to lay his hand on his memorandum, or to say which church it was. The vestry clerk who admitted him to the building said the churchwardens of the time did not like the price which the plasterer asked for this magnificent flower. It was about 10 feet in diameter, so several experts were called in to say what it was worth. The answer given was that no money would pay for it, it was so exquisitely done. He thought it might be St. Katharine's, in Fenchurch-street. With regard to the materials used, he refrained from enlarging on that part of Mr. Robinson's paper; but he had heard that when some work of this kind was done at the Duke of Devonshire's, at Chiswick—the whole of the exterior being covered with stucco—the neighbourhood was impoverished in the matter of eggs and butter-milk, which were taken to mix with the

stucco. There did not seem to have been anything used with the old well-slacked lime, beyond a little sand. This would render the suggested chemical examination unnecessary; the simpler it was the better. He was doubtful whether Nicholas Stone had anything to do with the ceiling referred to by Mr. Robinson. Many works were attributed to him which he thought Stone could not have been old enough at the time to have been engaged in: for instance, the wonderful tomb to Sir Francis Vere, in Westminster Abbey, a most extraordinary work, which Stone was hardly likely to have done, as some had suggested, seeing that in 1608, when Vere died, he was only a youngster of about 20 years of age.

Mr. H. LONGDEN said there was a very fine frieze in the great gallery at Hardwick-hall, nearly as deep as the pictures round that room, mostly hunting subjects; and he could confirm what had been said as to the work in the ruins. Old Bess of Hardwick, as she was called, built the new Hardwick-house, and pulled down the old one, or rather left it to decay; yet there was in one of the rooms of that old house a frieze very similar in the kind of ornament to that in the new one, which showed that it must have been in progress at the very time the new house was begun. That, therefore, was great evidence of durability. There was modelled stucco work over the chimney pieces in Hardwick, and the same in Haddon, where there was a quaint but not very beautiful example representing Orpheus over one of the chimney pieces. There was a good deal of fine work of this kind in the north of England, one fine specimen being in Wallington-hall, belonging to the Trevelyan. The house was built by Blackett, a merchant of Newcastle. The tradition was that the stucco work on the staircase and ceilings was done by Italians; it was certainly early 18th century work, but he had not heard of names of executants. This kind of art very rapidly spread, and it was much to be regretted it had died out. It was certain that those modellers who were now being trained would want work, and this would be a very good way to employ them; as had been said, they produced a good deal of very fine niggling sort of ornament, and if they would go in for a broader style it would be better. Such work was now being done, so that a start had been made, and they only had to go on.

Mr. ROBBINS, who said he had been engaged in plaster work all his life, produced various samples of a material which he had been experimenting on for some years, and which could be worked either by running in moulds or modelled by hand, and would also take any desired colour.

The CHAIRMAN, in proposing a vote of thanks to Mr. Robinson, said he thought he could best add to the interest of the discussion by telling them something of what he had learnt by personal observation.

He had been always much interested in plaster work, stucco especially, particularly that produced in the finest periods in Italy. He had had the good fortune to make the acquaintance of Signor Mariani, who produced the model mentioned by Mr. Robinson of the Villa Madama, and who was one of the most skilful men in Europe, having all the old traditions of the Italian minor arts. The next time he was in Perugia he asked Signor Mariani to show him how he did the work, and went with him into a carver and gilder's shop to see some stucco duro made. He used plaster of Paris, and, what was equivalent to the rye meal already mentioned, viz., flour paste, rather thin. With this the plaster was mixed until it was of about the consistency of pastry dough, and was rolled out just in the same way. It was then cut into pieces and pressed into a mould, and taken out again very rapidly, almost immediately. The material hardened quickly, though not so quickly as if made with English plaster; he believed size or weak glue was the best to retard the drying. He had been much interested in what Mr. Robinson said about the column in the Palazzo Vecchio, for he had never realised before how long they had stood in good condition, and it was most encouraging to those who were desirous of encouraging this work in England. When he was at Hardwick some few years ago, from the bottom of the wall in the old house where the frieze was, he brought away with him a few fragments of the old plaster, for the purpose mentioned by Mr. Stannus, but he had omitted to have them analysed, and could not find them in time to bring that evening. If, however, Mr. Stannus would undertake to have them analysed he would look them up. With regard to colouring stucco, he had made some experiments, and hoped that at some future time Mr. Robinson would go more at length into this and other branches of the subject. He understood that many of these beautiful works were first gilt, and then painted.

The vote of thanks having been carried unanimously,

Mr. ROBINSON, in reply, said he would just add a parting word on what Mr. Donaldson had said as to the three requisites, time, taste, and money. As for taste, that was a quantity which could not be expressed by words in any way. But stucco work certainly did not demand much time; it was about the quickest process for obtaining a result of any; nor was it by any means expensive. In many cases it would be quicker and cheaper than any other, even than modelling in clay, taking a mould, and then taking a plaster cast. Very often you wanted a thing which was right and left, the pattern being reversed; and there a double process of modelling and casting would be required. In stucco, you only had one process; and it was just as easy to model in stucco as in clay; you put it *in situ*, and the result was your own work, and it spoke for itself. Some eight or ten years ago he executed across

some gables of a building at Cowdray, near Midhurst, for Lord Egmont, a large hunting scene, with stags, &c. The tradition was that it had been a hunting-lodge, and the decorations were desired to be in character with it. This work had stood very well so far, not showing a sign of any decadence whatever. The whole work was done very rapidly, and was not costly. If stucco work were expensive, it would never have been so extensively practised; in fact it ran rampant all over Europe, and died out, because it was so cheap, that it led to so much poor work being done, and people got disgusted with it. The real thing that blocked the way was the want of a little humility on the part of the modellers, in assuming a blouse, and working on a scaffold. One of his objects in pointing out the great men who had done stucco work absolutely with their own hands was to show that labour of this kind really ennobled the man, and that his blouse was a garb of honour to him. He was much obliged to Mr. Papworth for much of his information, and to Mr. Longden also, and should be obliged if they or any other gentleman would send him notes they might have of any plaster work in England, for he did not intend to let the subject rest at the immature point to which he had been able, as yet, to carry his research.

FOREIGN & COLONIAL SECTION.

Tuesday evening, April 21st, 1891; Sir ALFRED LYALL, K.C.B., K.C.S.I., K.C.I.E., in the chair. The paper read was on "China," by Sir THOMAS WADE, G.C.M.G., K.C.B.

The report of the paper and discussion will be printed in the next number of the *Journal*.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 22, 1891; Professor H. S. FOXWELL, M.A., in the chair.

The following candidates were proposed for election as members of the Society:—

Bayley, Sir Steuart Colvin, K.C.S.I., C.I.E., 7, Glendower-place, S.W.

Cornett, James Porteus, Claxheugh-grove, near Sunderland.

Dunford, J. Williams, 100C, Queen Victoria-street, E.C.; and Linda, Pembroke-road, Walthamstow, E.

Vallance, Robert Frank, Cavendish-house, Mansfield.

The following candidates were balloted for, and duly elected members of the Society:—

- Bracewell, William, Brinscall, near Chorley.
 Brown, Prof. Gerard Baldwin, M.A., The University, Edinburgh.
 Davies, David, The Oriental Waterproofing Company, Wallis-road, Hackney-wick, E.
 Friend, Samuel, Cargate, Aldershot, Hants.
 Fryer, Frederic W., Loundoun-house, Surrey-street, Strand, W.C.
 Geen, Charles Alfred, 32, Mount Pleasant-road, Lewisham, S.E.
 George, John Bellamy, 37, Highbury-hill, N.
 Hirst, Hugo, 71, Queen Victoria-street, E.C.
 Knight, Charles A., 114, Newgate-street, E.C.
 Langton, E. G., 12, Matham-grove, Lordship-lane, S.E.
 Macpherson, George M., M.A., LL.D., Karachi, India.
 Maxwell, James, 29, Princess-street, Manchester.
 Michaelis, Philip, 21, Endsleigh-gardens, N.W.
 Porter, James Neville, 47, Upper Bedford-place, W.C.
 Prentice, Napier, 5, Queen's-road, Erith, Kent.
 Rosenthal, James H., Babcock and Wilcox Company, 114, Newgate-street, E.C.
 Sherrin, George, 33, Finsbury-circus, E.C.
 Southall, Bertram Norman, Beech-house, Redhill, Surrey.
 Tidman, Edward, 34, Victoria-street, Westminster, S.W.
 Weeks, Alfred W. G., 36, Gunter-grove, West Brompton, S.W.
 Wilson, Reginald P., 3, Prince's-mansions, Victoria-street, S.W.
 Wood, Gilbert, 32, Green-lane, Kettering.

The paper read was—

BIMETALLISM.

By SIR GUILFORD MOLESWORTH, K.C.I.E.

"Only fools are bimetallists!" This was the verdict of the Right Honourable Robert Lowe, Chancellor of the Exchequer, when asked by Mr. Pender whether there was anything in bimetallism. A few weeks ago, I was told by a friend that, in answer to a similar question, he was assured by a senior wrangler—a man well known in literary circles—that "as soon as a man begins to inquire into the nature of bimetallism, he ceases to be a bimetallist."

Now, this would, to some extent, represent the state of the case, if it had been supplemented by a single word—if it had been stated thus:—"A man ceases to be a bimetallist as soon as he begins to inquire *superficially*." I have spoken to

hundreds of men on the subject, and, almost invariably, I have received one or other of these answers: "Bimetallism is so abstruse a subject that I have not cared to investigate it;" or, "bimetallism is an absurd fad; and it is contrary to every principle of political economy to attempt to fix by law the relative value of two commodities like gold and silver."

This latter reply, accompanied by a contemptuous refusal to argue the question further, represents the superficial inquiry, which ends in the inquirer ceasing to be a bimetallist. Now let me give a few instances of those who have pushed the inquiry beyond the superficial limit. Two years after Mr. Lowe had given utterance to the opinion, that "only fools were bimetallists"—having dashed into controversy in the *Nineteenth Century*, in which he heaped upon bimetallists every epithet which his richly stored mind could find to express his contempt for their reasoning powers—he was forced to admit that he was beaten in controversy. He had the manliness to confess his defeat in the following quotation:—*Nec tam turpe fuit vinci, quam contendisse decorum*, which I may perhaps translate, "The disgrace of my defeat is eclipsed by the honour of such a controversy."

Mr. Gibbs, Governor of the Bank of England, at the public meeting in 1883, said:—

"Mr. Goschen and I were together on the Conference of Paris. Both of us were sturdy defenders of gold monometallism, but I have changed my mind; I do not say that Mr. Goschen has changed his mind, but I think he has somewhat modified it."

Mr. Gibbs is now the leading champion of bimetallism. The *Economist* threw down the glove to bimetallists, and Mr. Gibbs having taken it up, handled his adversary so roughly, that, after an exchange of broadsides, the *Economist* retreated beyond the line of fire—he found nothing to say by the way of a rejoinder.

How far Mr. Goschen has modified his opinions may be judged by the following quotation from his speech at Manchester:—

"There is a class of monometallists who say that bimetallism is all nonsense, and cannot understand what it means. Now I do not think it is nonsense at all—I think it is a very serious demand for a change, which, if adopted, would produce very large results. The action of the Latin Union and of Germany, the displacement of silver, and the enthronement of gold in its place in many countries, have had an immense effect in producing the changes which the bimetal-

lists deplore, and attempt to remedy. I fully appreciate the importance of the question, I find it is almost impossible to exaggerate its importance."

Mr. Samuel Smith, M.P., in a public speech stated that, like everyone brought up in this country, he was in favour of the single gold standard, and indisposed to believe in the power of law to fix a ratio between any two articles; he is now in the foremost rank of bimetallists. Jevons and Macleod, well known authorities in monetary science, and formerly monometallists, have admitted that the position of bimetallism is, from a scientific point of view, impragnable.

A few years ago, the number of bimetallists in England might have been counted on the ten fingers; now they are legion. Upwards of 100 members of Parliament favour bimetallism; 135 petitions in favour of it have been presented to Parliament from Chambers of Commerce, Trades Councils, Agricultural Associations, and Labour organisations. In the United States Mr. McCulloch, secretary to the Treasury, publicly retracted his former opinions in favour of monometallism. Mr. Ruggles, delegate of the United States, who in the monetary conference of 1867 was a strenuous opponent of bimetallism, in 1876 urged the "vital necessity of a conference for establishing bimetallism."

M. Vrolich, Minister of Finance for the Netherlands, for a quarter of a century a monometallist, became a strong advocate for bimetallism. In Belgium, M. de Laveye reduced to silence all the monometallists. In France, the *Journal de Debats*, formerly monometallic in its views, was converted to bimetallism. Signor Luzatti, the delegate of Italy at the Paris Conference, stated:—"Certain indications allow us to affirm that in Germany opinions are more and more divided between monometallism and bimetallism. It is evident that the latter system is daily gaining ground; it has on its side important economic authorities, whose names it is enough to quote—MM. Wagner, Schaeffle, Lexis, Arendt.

It has been defended in the Reichstag by several deputies, particularly by one of the leading members of that body, Herr Von Kardoff. It has been expounded and applauded at numerous public meetings, and by Germans at the annual congress. Lastly, a symptom more significant than any, Prince Bismark himself seems to have conceived doubts of the gold monometallic reform decreed ten years ago, by the German Government." The *Times*,

in an editorial, has stated "that free coinage in the United States would fix the ratio all over the world," although a few years ago bimetallists were stigmatised as lunatics for asserting that Great Britain, the United States, France, Germany, and other continental States in combination could accomplish this.

The English Government has admitted the efficacy of bimetallism, in its offer to keep a portion of its bank reserves in silver, on condition that the other states would return to that bimetallism from which they have departed. The Royal Commission, appointed in 1887, consisted of twelve members impartially selected from monometallists, bimetallists, and those who had no particular bias. After a patient investigation, lasting over a year, the Commission issued a report which conceded every principle for which the bimetallist contends.

The members were unanimous in the opinion that some step should be taken to "relieve the tension of the present situation"—to keep the value of silver stable relatively to gold; that Government should initiate a movement to promote the joint action of nations. The main, and almost the only, important point of difference between the members was, that six out of twelve of them declined to join their colleagues in recommending International Monetary Union on the basis of bimetallism, believing that the subject required further consideration. The report, as a whole, is a great triumph for bimetallism. The complete change of front in those eminent men who had previously been staunch supporters of gold monometallism, renders their admissions in favour of bimetallism all the more important.

It would be possible to multiply to any extent instances of conversion to bimetallism, when the subject has been fairly investigated otherwise than superficially.

It is in the hope of inducing discussion and unprejudiced investigation on the subject, that I have been induced to bring the question before the Society of Arts.

The double standard of France, until its abandonment in 1873, maintained, within close limits, a fixed relative value between gold and silver during the present century. A departure from this standard has, by altering the standard or value previously existing, injured credits, depressed trade, caused wide-spread economic disturbances, and stimulated those Nihilistic reactions which threaten Europe with revolution.

The remedy is simple—it is a return to the

double standard; but international agreement is necessary to effect this return. France and other continental nations having suffered acutely, were willing to join England in an International Monetary Union, which would at once restore the relations between silver and gold; but England, whose statesmen and economists have only lately begun to study the subject, holds back, and is the sole obstacle to the application of the remedy. Public opinion has been prejudiced by several popular fallacies. These fallacies are principally:—

1st. That bimetalism is so abstruse a subject that it is useless for ordinary people to master its principles.

2nd. That it is opposed to the laws of political economy.

3rd. That England owes her commercial superiority to her gold standard.

4th. That the fall of exchange is due to the over-production of silver, and is, therefore, without remedy.

I shall endeavour to refute these fallacies, and I shall then trace step by step, from the evidence of history and reason, the connection between the demonetisation of silver, the contraction of currency, the depression of trade, and the distress of the industrial and working classes. I shall endeavour to show:—

That the departure from bimetalism has created an insufficiency of gold for monetary purposes.

That this has caused a serious contraction in the volume of currency.

That it has been the direct cause of falling prices; which invariably cause suffering amongst the industrial classes.

That it has altered practically the terms of rents, leases, mortgages, and other agreements, contracted before the date of the demonetisation of silver.

That it has been the direct cause of the agricultural distress, and particularly of the discontent in Ireland.

That the disasters which have followed the abandonment of bimetalism were distinctly predicted, and that the prediction has been fulfilled with startling accuracy.

That the adoption of gold monometallism has falsified the world's standard of measurement of value.

That this falsification has introduced into commerce and trade an element of uncertainty, doubt, and distrust.

That it has also caused an inequitable transfer of value from the productive to the unproductive classes of the community.

Bimetalism, in its outlines, is extremely simple if divested of its side issues, and of the web with which false political economy has enveloped it. Its reputation as an abstruse subject is chiefly due to a dogmatic unenquiring prejudice, fostered by a misapplication of the laws of political economy, whilst arguments carried on from different points of view have woven a tangled skein around the subject, which has completely obscured its simplicity. The majority of treatises on the subject contain needless disquisitions on money, value, exchange, and other technicalities, treated in a manner calculated to generate confusion of ideas, and to mislead.

Throughout this paper I have used the term "bimetalism," because it has been generally adopted in England to express the double standard of silver and gold; but it is a misnomer, and, as Mr. Dana Horton has remarked, "when law and fact, theory and history, are jumbled together into 'one 'ism' of two metals, confusion reigns even in the best of heads."

I shall endeavour to clear off this tangled web, avoiding as far as possible all technicalities or difficult questions, and at the same time pointing out the manner in which this confusion has arisen.

Bimetalism, so called, is simply the adoption of two metals (gold and silver), at a fixed ratio, as the legal tender for payments. The ratio adopted in France was 1 of gold to 15½ of silver. Any person who has to make a payment (termed the "debtor") has the privilege of selecting either metal for that purpose. This is the whole sum and substance of bimetalism. I may here explain that the selection of the metal for payments does not practically enter into ordinary retail transactions; it is only called into play when large settlements are required, such as the adjustment of balances with foreign States, the payment of national loans, the reinforcing of bank reserves, or transactions of a similar nature on a large scale. When once the ratio has been fixed by legislation, it is automatically maintained, *not by the law*, but by the *action which legislation sets up*, through the agency of the laws of supply and demand. This automatic action is easily explained. Supposing a large settlement has to be made, the "debtor" (whether a nation or an individual) has the choice of the metal, and in selecting a metal he creates a "demand" for it, whilst in rejecting the alternative metal he causes the demand for it to fall

off. Of course he will select that metal which is least costly to him, or that which may be below the ratio, and with this demand arises a tendency to increased value; whilst, at the same time, the cessation of demand in the other metal tends to reduce to its value; thus if there should be any difference in the ratio, the metal of lower value has a tendency to rise, whilst the metal of higher value has a tendency to fall—the tendency in both metals being to approach the ratio. Of course this action extends throughout the world, wherever large movements of coin or bullion are concerned, and thus the ratio is automatically maintained within close limits. It is impossible that it should be otherwise, and this automatic adjustment of the double standard is extremely sensitive, for the slightest divergence in the ratio is carefully watched by the bullion brokers, and a demand at once springs up for that which is below the ratio, or falls off for that which is above it. When, therefore, the two metals are linked together as a double standard, they must find their equilibrium as surely as water finds its own level.

Jevons has aptly compared this equilibratory action to that which occurs in two reservoirs, each subject to independent variations of supply and demand. In the absence of a connecting pipe, the level of the water in each reservoir will be subject to its own fluctuation only; but open a connecting pipe, and the two find one common level. In monometallism the connecting pipe is wanting.

Let me extend the simile by comparing the cost of transport brokerage and commission, and to the friction in the connecting pipe, which accounts for slight and temporary divergences from the absolute ratio in the uncoined bullion; and, as friction diminishes in proportion to the size and length of the connecting pipe, so the divergence from the ratio must bear a proportion to the number and influence of those States which adopt the double standard. Two conditions are absolutely necessary for the maintenance of a double standard:—1st. That the coinage of both metals shall be free and unrestricted; 2nd. That the States adopting the double standard shall be of sufficient importance to influence the currency of the world. The reasons for these conditions are self-evident. A restriction of coinage establishes a difference of value between the coin and the bullion of a metal, and at once destroys the equilibratory actions above described.

France, single-handed, was of sufficient monetary importance to maintain the ratio, under the most trying conditions, for three-quarters of a century, until it abandoned the double standard, in 1873, by restricting the coinage of silver.

I will now point out the manner in which the laws of political economy have been misapplied, and the question needlessly confused, by arguments carried on from different points of view.

Cossa, the well-known Italian political economist, has given the following warning to students in the science of economics:—

“It is needful to hold ourselves aloof, equally from the so-called *doctrinaires*, who refuse the assistance of practice, and from the empiricists, who obstinately close their eyes to the light of theory. The *pure* science explains phenomena, and determines laws; the *applied* science gives guiding principles, which practice brings into conformity with innumerable varieties of individual cases.”

It would have been well if monometallists had taken to heart this sensible advice,

The *doctrinaire* argues:—“Silver and gold being two commodities, must be subject to the ordinary laws of supply and demand. *Therefore the double standard cannot be maintained.*” I admit freely the truth of the first portion of the *doctrinaire's* argument; gold and silver are commodities, subject to to the ordinary laws of supply and demand; and I go further than this, I contend that to to those laws bimetalism owes its compensatory action, but the *doctrinaire* is wrong in the latter portion of his argument, viz.—“Therefore the double standard cannot be maintained at a fixed ratio.”

The empiricist, on the other hand, knows by experience that the double standard has been maintained for an indefinite length of time, notwithstanding enormous fluctuations in the supply of either metal; and he argues that “precious metals are not commodities, and consequently the ordinary laws of supply and demand are not applicable to them, but are subject to certain occult monetary laws, which fix the relative value at the legal ratio, and therefore the double standard can be maintained at the fixed ratio.”

Now in this argument the *doctrinaire* and the empiricist are both wrong and both right. The *doctrinaire* is right in his theory, but wrong in the application of that theory; on the other hand, the empiricist is wrong in his theory, but fortunately he is right in his conclusions. His theory is wrong *only in*

the sense of his adversaries' argument, that legislation cannot fix relative value, and that the law of supply and demand does not apply to the precious metals.

Legislation cannot maintain a relative value, but it can set up an action which does maintain it. This will be self-evident from the explanation which I have already given of the action of metals under a double standard, showing that a demand is naturally set up for the metal which is below the ratio, whilst the demand ceases for that which is above the ratio, thus setting up an automatic action which, through the laws of supply and demand, confines any divergences from the value within any close limits.

Law does not give value to a metal, but it creates a demand which does give value. In like manner, legislation does not maintain a fixed ratio between the two metals, but it sets up an action, by means of the demand, which can and does maintain the equilibrium. Legislation does in one sense maintain the ratio, yet not in another. Money is a commodity in one sense, yet not in another; when it is the measure of commodities, it cannot be that which it measures.

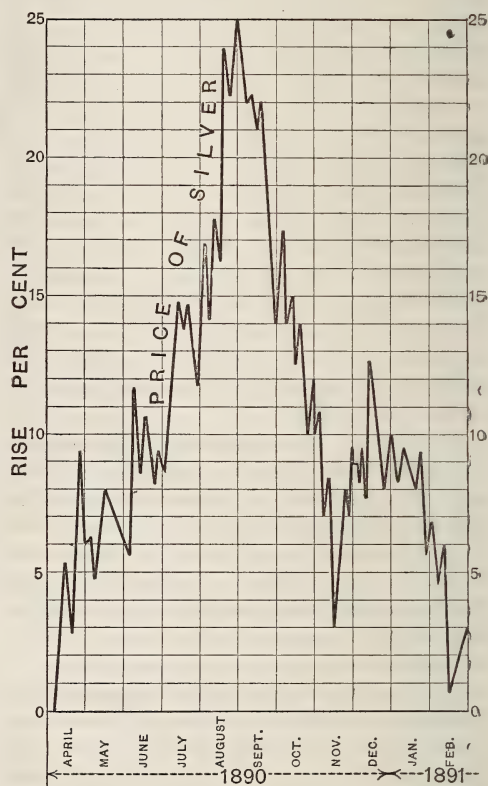
The *doctinaire* argues—the law of supply and demand which regulates the value of precious metals pays no heed to the commands of legislation. The empiricist, on the other hand, can point out innumerable instances in which legislation has affected the value of precious metals in the most unmistakeable manner.

Take, for instance, the recent case in which the mere belief in the passing of a Bill for the free coinage of silver in the United States suddenly ran up the price of silver 25 per cent.; and, shortly afterwards, failing hope in the proposed legislation caused the value of silver to fall as rapidly as it had risen. (See Diagram, Fig. 1.) The *doctinaire* is right in his theory, if he confines it to the statement, that legislature cannot alter the laws of supply and demand; but he is wrong, when he denies that those laws pay no heed to legislation. The maintenance of the ratio under bimetallism is not a suspension of these laws, but, on the contrary, an active exercise of their functions.

The argument of the monometallist is the dogmatic argument of a *doctinaire*, in defiance of all evidence to the contrary, and in contradiction of all observed facts and practical experience. It is a simple misapplication of the laws of political economy. We see then that money is a commodity in one sense, yet not in

another; that law can give a value in one sense and yet not in another; that legislation can maintain a relative value between gold and silver in one sense, yet not in another; and hence has arisen much of the existing confusion from arguments carried on from these opposite points of view; so that bimetallists have been taunted with inconsistency, as they maintained one side or the other.

FIG. 1.



FLUCTUATIONS IN THE PRICE OF SILVER DUE TO PROPOSED MONETARY LEGISLATION IN THE UNITED STATES.

Few have rendered greater service to the cause of the double standard than Henri Cernuschi. Yet, strangely enough, few have provoked more opposition from economists than he has done, by his persistent refusal to admit that gold and silver, when coined money, are commodities, and by denying the scarcity of gold. From his point of view he is correct.

Bimetallism is neither new nor untried, it has stood the test of experience, whilst the departure from it in Europe has been an experiment that has been accompanied with disastrous results. The double standard of gold

and silver, in more or less imperfect form, has existed from time immemorial. There are records of its existence in Asia, Greece, Egypt, and India, at periods varying from 200 to 400 years B.C. Civilised Europe has always practically had a double standard until 1873, although individual States have altered their standards from time to time. The standard of England, for instance, has been in turn silver monometallic for three centuries, then spurious bimetallic, with gold as money, but rated from time to time with reference to silver, for three centuries, then silver monometallic for half a century, then spurious bimetallic for half a century, but only since 1816 gold monometallic.

History distinctly proves that the confusion which has existed in past times has been entirely due to neglect of the establishment of an international ratio between gold and silver. Failing this, each metal has naturally from time to time sought the best market, and this has led to injudicious monetary changes and debasement of coins; and to the creation of that which is termed in "Gresham's Law" "good" or "bad" money.

The currency of England was silver monometallic—although golden coins were also used—until the reign of Edward III., when gold was made a legal tender at a ratio fixed from time to time by the State. In the reign of James I. the quantity of the gold in coins was reduced to prevent its export: but this was overdone, and induced the export of silver in its turn.

In the reign of Charles II. the guinea was coined with the intention that it should pass current for 20 shillings, but the amount of gold in it was such that it was thought necessary to declare its value at 22 shillings; it proved, however, to be overrated at that value, and was subsequently rated at 21 shillings and sixpence. In 1717, it was rated at 21 shillings; this fixed the ratio in England at 1 to 15½. If Newton's advice had been followed, it would have been rated at 20s. 6d., which would have approached the Continental ratio, and, as the ratio on the Continent was then 14½, the silver of England, seeking the best market, was exported. In 1730 Spain changed her ratio to 1 to 15·87, and this induced a return of silver to England. If an international ratio had existed there would have been no inducement to export one metal in preference to another. In 1774 England limited the legal tender of silver to £25, but she did not adopt a gold monometallic standard until 1816.

France, in 1789, established on a sound basis that simple and perfect system of double standard which maintained, unbroken, the parity of gold and silver coins, until 1873, when the link between gold and silver was foolishly broken by a restriction of the mintage of silver in France.

The United States had a bimetallic currency from the foundation of the Union until 1873. The original ratio in the United States was 15 to 1; whilst that of France was 15½ to 1. In each of these countries the metal naturally sought the market which afforded the most advantageous terms, resulting in a tendency to exportation of gold to France. In order to rectify this tendency, America, in 1834, foolishly adopted the ratio of 1 to 16, although she had been advised by all her experts to adopt 15½. This, again, tended to the export of silver; but although each metal sought the most advantageous market, the ratio of 15½ was maintained in Europe with but very slight variation. During the Civil War in America, however, specie payment was suspended in the United States, and was not resumed until 1879; meanwhile silver was surreptitiously demonetised in 1873; but the fact was not discovered until 1875, when the endeavour to return to the double, standard led to the passing of the Bland Act as a compromise, but this Act, though intended to tide over a difficulty, is a dangerous experiment; it causes the silver dollar, whilst circulating at full legal value, to be useless as international money, for it loses its value on exportation. It is a violation of the first principles of monetary science, and must lead to disaster unless the double standard be eventually re-established.

In 1867, misled by false political economy, the report of the Monetary Conference recommended the establishment of a gold monometallism in Europe; and an insane crusade was waged against silver. England's Chancellor of the Exchequer, Robert Lowe, urged France to give up her double standard, and adopt gold. In consequence of this fatal blunder, Germany, on the receipt of the war indemnity in 1871, abandoning her silver monometallism, threw her silver on the market; and France, in a weak moment, shaken in the adherence to bimetallicism by the foolish persistence of England's Chancellor, and by the attitude of the Conference of 1867, restricted the mintage of silver coins, thus breaking the link which had preserved the ratio.

The evils resulting from the demonetisation of silver soon forced themselves upon the

world. Germany, discovering that she had made a blunder, halted halfway in her gold monometallism, leaving the greater portion of her silver thalers in circulation at a legal-tender value of the nominal gold equivalent, thus adopting the "limping standard" (*étalon boiteux*). The United States and Europe took alarm. The International Monetary Conference met at Paris in 1878, and completely reversed the decision of the Conference of 1867, being unanimous in the opinion that the "re-habilitation of silver is necessary," but trusted to time to set matters right. In 1881, the delegates still more strongly urged the re-habilitation of silver. The United States delegates presented a plan of practicable scheme for international agreement, which would have restored the ratio between silver and gold; and the other States approved, provided that England would do so; but England, though practically admitting the efficiency of a bimetallism union, by stipulating with the other Powers for a return to bimetallism, as a security for keeping a portion of her reserves in silver, refused to join in the movement.

There is prevalent in England a fetich worship of gold which rests on no sound basis. Mr. Goschen has aptly remarked: "I am aware that most of the monometallists hold their views so strongly, that many of them, like the most orthodox religious people, are unable to give an account of their belief."

One of the most important of the articles of belief in this creed is that "England owes its commercial superiority to its gold standard." Now, I have never been able to obtain from those who hold this creed any explanation of the *modus operandi* of the manner in which gold acts so as to have performed this miracle. The only plausible solution that has ever been offered to me is that "obligations payable in England secure payment in gold, and consequently induce the foreigner to hold bills payable in London, and thus attract capital."* But this explanation does not account for the phenomenon; for, during a considerable portion of the time that England had a gold standard (that portion being the period of our greatest prosperity), it

was a positive disadvantage to be paid in gold, silver being at a small premium. If, however, it were possible that anything could shake the faith of the orthodox believer in this dogma, it should be the fact that the commercial superiority of England was established before she adopted her gold standard.

Alison, in his "History of Europe," describing the rapid growth of wealth and prosperity in England at the commencement of this century, fifteen years before the adoption of our gold standard wrote:—"The monopoly of almost all the trade of the world was in its hands." We have that monopoly no longer; other nations are gaining on us "hand-over-hand."

In 1815, the year before England adopted her gold standard, the commerce of England under a bimetallic standard had increased 50 per cent., when compared with the year 1800, and the revenue had increased 110 per cent. In comparing 1830 with 1815, or fifteen years succeeding the adoption of the gold standard, the increase of commerce was only 28 per cent., whilst the revenue had fallen off by 22 per cent., although these years were marked by profound peace. Our commercial superiority is owing to the energy and determination of the Anglo-Saxon race; to its insular position; to its good harbours; and to its two centuries of internal peace and accumulating capital; and it has been maintained *in spite of the disadvantages of our currency*.

The adoption of the gold standard in England was opposed by Ricardo, and State documents, lately discovered by Dana Horton, have proved incontestibly that the grounds on which Lord Liverpool based his recommendations were diametrically opposed to facts.

The gold standard of England has been from first to last a source of inconvenience and danger, and it has only been saved from serious disaster by the bimetallism of France—notably at the time when the discoveries in California and Australia flooded Europe with gold. Then Cobden and Chevalier urged that contracts should be made in some other standard than gold; it was predicted that the value of the sovereign would fall to fourteen shillings, and Chevalier even prophesied that the value of gold would decline 50 per cent., predictions which would probably have been fulfilled had it not been for the equilibratory action of the double standard of France, which kept the ratio stable, and thus prevented a disaster of unprecedented magnitude.

It is patent to everyone who has studied the question, that the English monetary system

* Mr. Goschen would seem to give countenance to this superstitious worship, by some words in his Leeds speech, when he lays stress on our bills held by foreigners being payable in gold. But this must mean gold, not as distinguished from silver, but as distinguished from paper. He must certainly have meant money of full weight and fineness, for while bimetallism prevailed, even in France alone, silver answered this description just as gold did.

is most unsatisfactory. In 1828, Mr. Baring (no mean authority) pointed out the evils of our system, recommending a return to the double standard, which he showed to be less subject to those sudden jerks and changes so fatal to credit and commerce; he urged that our gold standard exposed the country to stringencies which cramped the currency and increased distress. The Bank Act has, on several occasions, been either suspended or on the verge of suspension, and, in 1858, Mr. Gladstone stated, "I cannot consent that the law should be suspended at intervals to meet these constantly-recurring crises. The Bank Act, damaged in 1847, was utterly shattered in 1857."

Our Bank reserves are diminishing, whilst our liabilities are largely increasing; they are inadequate to the necessities of the country, and are too small, as compared with the gigantic liabilities we have incurred. In 1883, Mr. Williamson, M.P., called attention to the alarming manner in which the reserves of the Bank of England had diminished from our inability to maintain them, caused by the competition of foreign nations for gold. During the ten years ending 1889, the proportion of cash to liabilities had fallen about 20 per cent. In June, 1881, the Bank reserves were 41 millions; they have now fallen to 24 millions. Germany has 40 millions, France 95 millions.

During the seven years, 1883-90, the Bank of France only changed its rate of discount seven times, whilst the Bank of England changed it sixty-two times, the variation in France only amounting to 2 per cent., whilst those in England have amounted to 4 per cent.

Mr. Goschen, in the House of Commons, last April, said: "I feel a kind of shame that on the occasion of 2 or 3 millions of gold being taken from this country to Brazil, or any other country, it should immediately have the effect of causing a monetary alarm throughout the country."

Then came the Baring failure, and our weakness was shown by having to call France to our aid.

The currency of France has weathered, without difficulty, storms to which the Baring failure was mere child's play; for example, the Franco-Prussian war, the Communistic struggle, the war indemnity, and the failures of the Panama Canal, of the metal ring, and of the *Comptoir d'Escompte*.

In contrast to this, I may quote from the

speech of Mr. Goschen at Leeds, his opinion on the gravity of the situation from the Baring failure. On that occasion he said; "You risked the supremacy of English credit, the transfer of the business of this country to other European countries. I cannot exaggerate the immediate danger to which this country was exposed. . . . You have escaped from a catastrophe which would have affected every town, every industry—to use a common phrase, you have escaped by the skin of your teeth."

Mr. Giffen has stated that in 1873 and in 1875, and in almost every year since 1876, "There has been a stringency of greater or less severity, directly traceable to, or aggravated by, the extraordinary demands for gold, and the difficulties of supplying them." Cernuschi said:—"England has suffered many monetary crises, simply because she had only one metal in circulation."

Professor Roscher says:—"I consider the adoption of gold as the exclusive basis of legal payments a disaster."

Dr. Suess says:—"The desire to make gold everywhere the only coinage, to the exclusion of silver, is pure madness. Geology opposes it; there does not exist in the world gold enough for this purpose."

It was generally supposed that the adhesion to the gold standard had secured to England a large stock of gold which has now appreciated in value. But Ernest Seyd's analysis of the quantity of precious metals in the world proved that France, with her bi-metallic standard, held double the amount of gold possessed by England.

Disraeli, in 1873, predicting the present monetary difficulties, said:—"It is the greatest delusion in the world to attribute the commercial preponderance and prosperity of England to her having a gold standard." England is neither monometallic nor bimetallic, but bi-monometallic—in an indefensibly illogical position, with a different standard in different parts of her dominions.

Fortunately England, although her currency was nominally monometallic, practically enjoyed the benefits of bimetalism, except when she had to depend on gold for replenishing her bank reserves, or when she had to make large remittances to India, and then she had to pay for her folly in the shape of a premium for the particular metal she might happen urgently to require. If she could have satisfied her requirements by either metal she would not have been put to this expense. But so long as Europe, as a whole, remained prac-

tically bimetallic, England in all her vagaries was kept tolerably straight by the double standard of France, which preserved the ratio of gold and silver throughout the world, until the link was broken in 1873.

The objection that silver is too heavy for currency is based on two mistakes; first, that in retail payments of large sums, silver, under a double standard, would be used more than at present as a substitute for gold or cheques; and second, that the rate for the transport of bullion is dependent on its weight or bulk. Freight, insurance, commission, brokerage, are always rated on a per-centage of the value; consequently silver costs no more than gold for the transport of a given sum.

The popular fallacy that the fall in exchange since 1873 is due to the over-production of silver is easily disproved.

In the first place, during the years 1873-80 inclusive—the years that witnessed the first unprecedented fall in exchange—the annual production of gold in the world largely exceeded in value that of silver.

2nd. The value of gold produced in the United States in 1873-80 exceeded that of silver by about 7,000,000 dollars.

3rd. The annual value of silver produced in the United States in that period averaged only about £7,000,000; an amount altogether insignificant compared with the enormous value of gold poured into the bullion market at the time of Australian discoveries of gold, averaging £30,000,000 sterling per annum; but even this deluge failed to disturb that equilibrium between gold and silver which the bimetallism of France had maintained for three-quarters of a century, under the most trying circumstances.

4th. Diagram Fig. 2 shows that the fluctuations in relative production of gold have been enormous, whilst, on the other hand, the fluctuations in relative value have been scarcely perceptible, until the abandonment of bimetalism by France in 1873.

It will be seen that the relative production of gold did not fall below that of silver until the year 1882, and that it has never been relatively so low as it was for the first 40 years of the century, when silver preserved its ratio to gold almost unchanged.

The accompanying Table (p. 465) of the mintage of metals in France shows a still greater contrast between the fluctuation of supply and value.

5th. Over-production of silver would naturally cause silver prices to rise, but silver prices

FIG. 2.

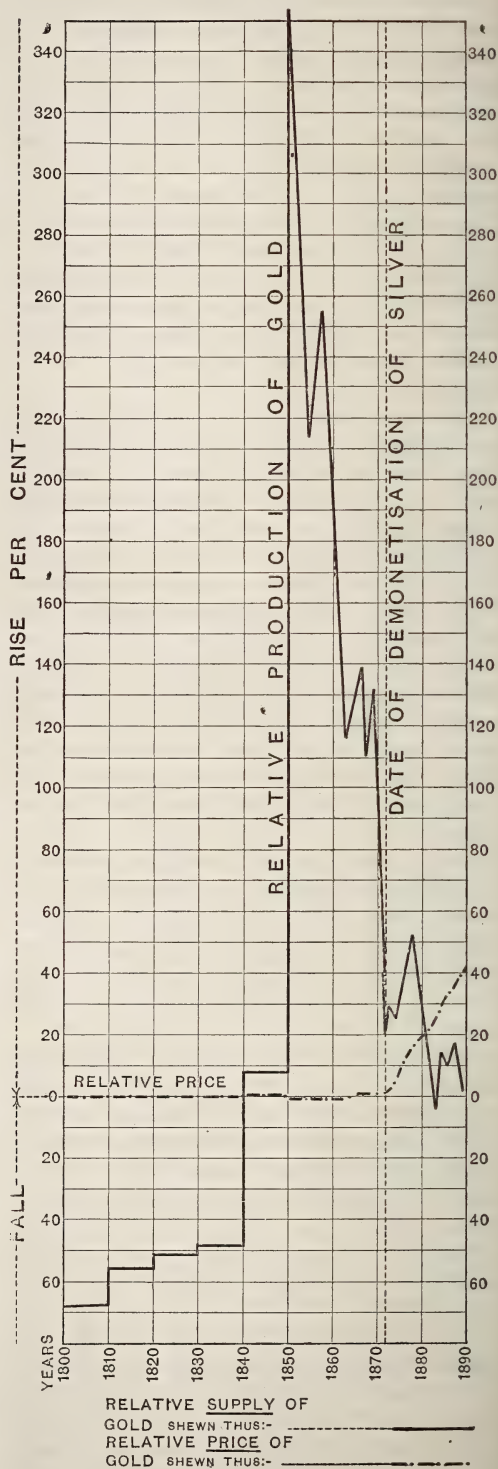


Table submitted to the Paris International Monetary Conference, 1881, by M. Pierson, Delegate for the Netherlands.

MINTAGE OF GOLD AND SILVER IN FRANCE FROM 1803 TO 1873.

Period. Years.	Millions of Francs minted.		Rela- tive value. 1 in	Relation of Gold to Silver.		Length of each period. Years.
	Gold.	Silver.		Supply.	Variation from par.	
				Per cent.	Per cent.	
1803-20.	865	1,091	15.58	Less 21	More $\frac{1}{2}$	18
1821-47.	301	2,778	15.80	" 89	" 2	27
1848-52.	448	543	15.67	" 17 $\frac{1}{2}$	" 1	5
1853-56.	1,795	102	15.35	More 1,660	Less 1	4
1857-66.	3,516	55	15.33	" 6,292	" 1	10
1867-73.	876	587	15.62	" 49	" $\frac{3}{4}$	7

have not risen, as may be seen by reference to Diagram No. 5 (p. 466).

In the face of such conclusive facts, it is absurd to argue that the over-production of silver could have been the cause of the fall in exchange.

It must be borne in mind that France, in maintaining the ratio, had to contend with great difficulties and disturbing factors. Germany, with its silver monometallism had to make up its bank reserves only with silver; England, with its bi-monometallism, at one time reinforcing its reserves with gold, at another time running over the Continent to purchase silver for transmission to India. Then, again, a different ratio existed in the United States—at one time 1 to 15, at another time 1 to 16—these differences tending, from time to time, to draw one metal or the other from circulation, and to increase the difficulty of maintaining the equilibrium. Added to this, during the first half-century Europe was without the equalising effect which rapid steam navigation and the electric telegraph now exert on prices in the bullion market. In former days, as a rule, six months was required to obtain market prices for India; now it only requires so many hours. Taking into consideration these difficulties, it is marvellous that the equilibrium should have been maintained by France single-handed; and that she was able to do so at all proves that if the United States and the great Powers of Europe would join in an international convention, with a uniform ratio, the equilibrium must be absolute throughout the whole civilized world, and all incentive to the preference of one metal over the other must be annulled.

Controversy has raged fiercely round the standard of "gold scarcity," some concluding that gold is scarce, others denying it on the ground that money was never so cheap as now. This contention is based on ignorance of the difference between a low interest for loans and an insufficiency of gold. "Cheapness" depends on the demand for loans, whilst an insufficiency of gold, by depressing enterprise, causes the demand to fall off. "Cheapness" of money, therefore, as a rule, is the result of a contraction or insufficiency of currency.

In one sense gold is not scarce. The stock of gold in the world is probably not less than formerly; but gold has now to perform, single-handed in Europe, that duty which was previously performed by gold and silver combined, and even more. Söetbeer estimates that the consumption of gold outside the United States, for industrial purposes, now somewhat exceeds the total yearly supply of gold to these countries. Germany has replaced her silver currency by gold, and the resumption of specie payments in Italy has increased the demand for gold; and silver being no longer stable when measured by a gold standard, is not available as a sound medium of reserve; for, as it loses its value on exportation, it is useless as international money. Under such conditions, the appreciation of gold is inevitable. Of course gold measured by gold cannot alter in value; its change in value can only be tested by alteration in its purchasing power, or, in other words, by the rise or fall in gold prices.

When the extraordinary fall of exchange, after the demonetisation of silver, first attracted attention, it was almost universally attributed to a depreciation of silver, but thoughtful observers, on applying the true test of their purchasing power to the two metals, discovered that silver had not depreciated, but gold had appreciated. This has been placed beyond all doubt by simultaneous investigations in England, India, the United States, and the Continent.

Diagrams, Figs. 3, 4, and 5 (p. 466), which I have prepared, exhibit this very clearly. Measured by gold, it will be seen that the fall in silver and commodities have been nearly coincident—the connection has been too close to be accidental—but between 1800 and 1873 the divergence was confined by bimetallism, and within very narrow limits. (See diagram.) Taking commodities as the standard of measurement, it will be seen that silver has re-

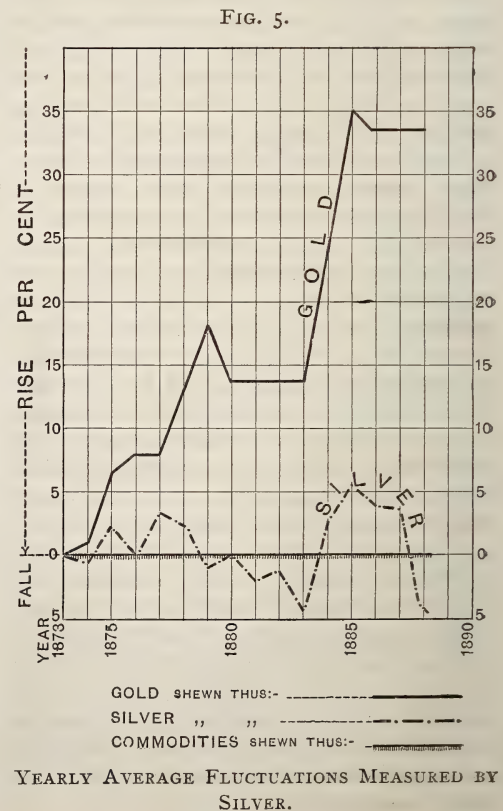
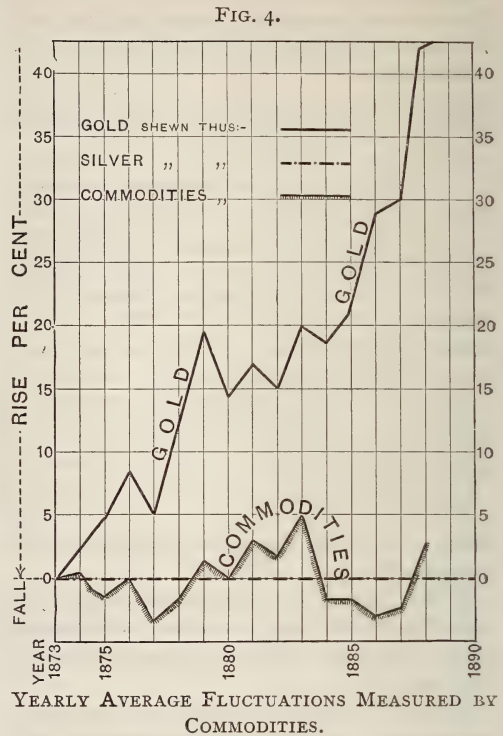
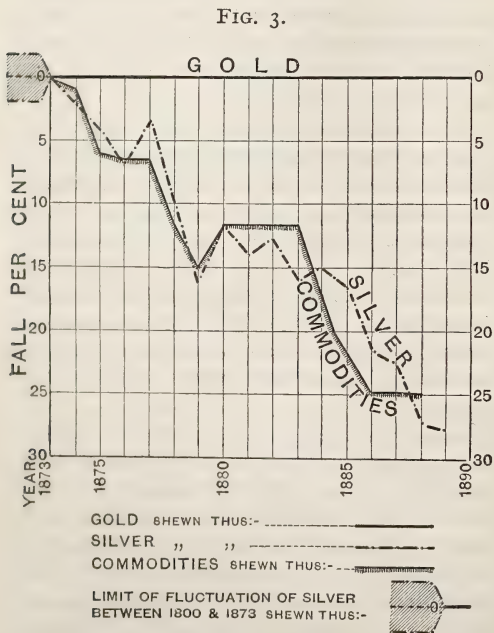
mained fairly stable, whilst gold has appreciated largely.

It is, therefore, evident that the demonetisation of silver in Europe, by contracting the currency, has caused an insufficiency of gold for the work it has to perform, consequently the increased demand has caused appreciation of gold, or, in other words, a fall in prices.

I shall now proceed to show that falling prices always have produced, and always must produce, depression of trade and distress amongst the industrial classes.

It is easy to appeal to the passions of the uneducated masses with the cry of cheap provisions, but, as Alison remarked, "few can be brought to understand or take any lasting interest in the far more important influence of a plentiful or contracted currency on prices;" on this account the monetary system is never selected as a *cheval de bataille* by democratic leaders. As it does not afford the means of arousing the masses, it is not one to tempt individual ambition, and the consequences of changes in the currency are too often unrecognised, or attributed to other causes.

Mr. Baring, in commenting on the disasters caused by a contraction of the currency in 1819, remarked:—"An alteration in the value of currency is what few, even the wisest, generally perceive. They talk of an alteration



in the price of bread and provisions, never reflecting that the alteration is not in the value of those articles, but in that of the currency in which they are paid."

Many able writers, notably Hamilton, Hume, McCulloch, Mill, Cairnes, and Jevons, have dwelt on the evils of a contracting and the benefits of an expanding currency.

The peculiar effect of a contraction "in the volume of currency" is to give profit to the owner of "unemployed money through the appreciation of its purchasing power, by the mere lapse of time." Falling prices rob labour "of its employment, and precipitate a conflict between it and capital." Money is withdrawn from circulation and hoarded, "in consequence of falling prices, neither paying wages nor serving to exchange the fruits of industry, nor performing the true functions of money." History abounds with instances of the evil effect of a contraction of currency.

In the reign of Augustus, the value of precious metals circulating in the Roman Empire amounted to £380,000,000, but in the reign of Justinian it diminished to about £80,000,000, and the coinage was debased. Under this contraction of the currency, agriculture and industry were ruined; the revenue could not be collected; the legions for the safeguard of the Empire were reduced from 650,000 to 150,000 soldiers, and, as Alison has shown in his "History of Europe," the fall of the Roman Empire, so long ascribed in ignorance to slavery, heathenism, and moral corruption, was, in reality, caused by the contraction of currency consequent on the decrease in the gold and silver mines of Spain and Greece.

At the commencement of the 9th century, the value of the stock of precious metals in Europe had fallen to £30,000,000, and at the close of the 15th century it did not exceed £40,000,000. Alison, describing this period, states that "the working classes of Europe were sunk in a state of debasement from which extrication seemed hopeless;" but, in 1545, the silver mines of Potosi were discovered, and the results are thus described by Alison:—

"The expansion of the currency which followed the supply of precious metals after the discovery of America by Columbus, induced an extraordinary flow of prosperity in Europe. The supply of precious metals was trebled; the prices of the species of produce quadrupled; the weight of debt and taxes wore off under the influence of that prodigious increase; in the renovation of industry the relations of society were changed; the weight of feudalism cast off; the rights of man established."

Macleod mentions the existence of a petition in 1816, protesting against a measure which the petitioners stated would result in a contraction of currency, which would greatly increase the taxes, to "lower the value of all land and commercial property, seriously affect and embarrass both public and private credit, embarrass and reduce all the operations of agriculture, manufactures, and commerce, and to throw out of employment a great proportion of the industrious and labouring classes of the community."

This prediction was fulfilled, for Alison states:—"The effects of this contraction of the currency were soon apparent, and they rendered the next three years a period of ceaseless distress and suffering in the British Islands. Prices declined in general within six months to half their former amount, and remained at that low level for the next three years. Distress was universal in the later months of 1819." Mr. Baring said in the House of Commons:—"Petitions are coming in from all quarters, remonstrating against the state of suffering in which so many classes are involved, and, more than all, the agricultural classes. When such is the state of the country in the sixth year of peace, when all the idle stories about over-production and under-consumption, and such-like trash have been swept away, it is natural to inquire into the state of a country placed in a situation without a parallel in any other nation or time. . . . What we are now witnessing is the exact converse of what occurred over the whole world from the discovery of the mines of Mexico and Peru."

Again Alison wrote:—"With the steady contraction of currency by the Bank of England, which began in July, 1836, prices fell during the whole of the ensuing winter; and in the spring of 1837 the panic was universal. Many bankruptcies took place; but, as prices of all sorts of manufacturers' produce had sunk nearly a half, the manufacturers were under the necessity of lowering wages; and this soon induced strikes in nearly all the branches of skilled industry."

From this distressed condition Europe was relieved by the expansion of currency, on the discoveries of gold in California and Australia, which increased the annual supply from £10,000,000 to £35,000,000 sterling.

The result is described in the History of Europe as follows:—

"The era of a contracted currency, and consequent low prices and general misery, interrupted by passing

gleams of prosperity, was at an end. Prices rose rapidly and rose steadily; wages advanced in a similar proportion; exports and imports enormously increased, while crime and misery as rapidly diminished; wheat rose from 40s. to 55s. and 60s.; but the wages of labour advanced in nearly as great a proportion; they were found to be about 30 per cent. higher on an average than they had been five years before. In Ireland the change was still greater, and probably unequalled in so short a time in the annals of history. Wages of country labour rose from 4d. a day to 1s. 6d. or 2s.; convicted crime sank nearly a half. At the same time, decisive evidence was afforded that all this sudden burst of prosperity was the result of the expanded currency, and by no means of free trade, in the fact that it did not appear till the gold discoveries came into operation, and then it was fully as great in the protected as in the free-trade States."

And now once more, in this present time, we are again suffering from a contracted currency, brought on not by natural causes, but by the inconceivable folly of a doctrinaire legislation. Such results of a contraction or expansion of the currency are easily explained. When trade is active, money is required for that rapid circulation and monetary activity which, naturally spreading from wholesale production to retail consumption, extends to all classes of the community. It matters not whether the medium of this circulation is actual coin, bank notes, drafts, bills, or other substitutes for coin; but it is absolutely necessary that there should be a reserve of coin or bullion proportioned to the amount of the paper substitutes or money that may be advanced. Mr. Goschen, in his speech at Leeds, has shown the terrible danger attending the issue of unsecured paper money. The bank reserves of coin or bullion, although apparently idle in the bank vaults, are, in times of activity of trade, actually performing all the functions of money, even to a greater extent than if they were themselves in active circulation as coin, because the amount of paper money which may be safely advanced on their security represents a larger volume of precious metal than the absolute value of the reserve. When a contraction of currency occurs, the banks, in order to secure themselves from loss by the drainage of their reserves, are obliged to raise the rate of discount. This discourages the borrowing of money, and induces the sale of the products of industry at lower rates, production is checked, credit is shaken, and wholesale prices fall. The export of goods which are already produced (or of which the continued production is neces-

sary, in order to keep up existing manufactures) continues; but it becomes unremunerative. Employers of labour have either to reduce wages or to work short time; competition for employment forces the operatives to accept such alternatives; all classes have to economise, and this reacts on retail dealers, increasing the general depression; but the retail prices do not immediately follow the wholesale prices in their fall, because a fall which is sufficient to check enterprise, is scarcely sufficient to affect appreciably the retail prices, at all events for a considerable period; and the difference is generally absorbed by the middleman. Consequently, the working classes do not benefit by the reduced prices, or, at all events, to an extent commensurate with their loss of employment or reduced wages.

Class is set against class; internecine wars arise between capital and labour, reacting on trade. The rate of interest falls, not from abundance of capital, but from absence of demand, from the knowledge that capital cannot be profitably employed. Capital is congested, but it is not the congestion of superabundance; it accumulates, and the bank reserves, in this case, instead of performing the true functions of money, are little better than impoverishing hoards.

As Moreton Frewen has justly remarked, "Land and capital are despoiled, and enterprise is decaying, that a nation's creditors may grow fat in idleness on the unearned increment of gold."

Falling prices affect agricultural interests in a different, but in a no less fatal manner. Rents, mortgages, taxes, and loans—contracts extending over long periods—have to be satisfied in an appreciated standard. The farmer is forced, in the case of rents or borrowed capital, to raise larger crops, or to reduce expenditure, in order to pay with equal profit the same rent or interest that he had to pay when prices were higher. The farmer is probably obliged to discharge his labourers, or reduce their wages; the landlord loses his rent, and checks his expenditure; neither he nor the tenant can afford the cost of substantial improvements; land goes back into cultivation, and becomes foul and poor; only necessary work is done, and the poor land goes out of cultivation altogether. Farm labourers, thrown out of work, have recourse to the manufacturing towns, and swell the ranks of the unemployed, tending to increase the distress in other industries; but in Ireland, where the population is almost entirely agricultural,

the labourers have nothing but emigration to fall back upon, and this is, in reality, the principal source of discontent in that unfortunate country.

In 1871, Ernest Seyd, protesting against the proposal for demonetising silver, made the following remarkable predictions:—

“It is a great mistake to suppose that the adoption of the gold valuation by other States besides England will be beneficial. It will only lead to the destruction of the monetary equilibrium hitherto existing, and cause a fall in the value of silver, from which England's trade and the Indian silver valuation will suffer more than all other interests, grievous as the general decline of prosperity all over the world will be. The strong doctrinarianism existing in England as regards the gold valuation is so blind that, when the time of depression sets in, there will be this special feature. The economical authorities of the country will refuse to listen to the cause here foreshadowed; every possible attempt will be made to prove that the decline of commerce is due to all sorts of causes and irreconcilable matters. The workman and his strikes will be the first convenient target; then speculation and over-trading will have their turn. . . . Many other allegations will be made, totally irrelevant to the real issue, but satisfactory to the moralising tendency of financial writers. The great danger of the time will be, that, among all this confusion and strife, England's supremacy in commerce and manufactures may go backwards to an extent which cannot be redressed when the real cause becomes recognised, and the natural remedy is applied.”

Two years afterwards, silver coinage was restricted, and a depression of unexampled severity set in, spreading over England, the Continent, and the United States. This depression has prevailed with greater or less stringency for about sixteen years, nor does there appear to be any symptom of its probable abatement.

England, as was predicted, appears to have suffered most severely. Her silk, woollen, and cotton industries have been struggling for existence; iron industries are said to have lost £160,000,000 in four years, but the agricultural industry appears to have suffered the most. In 1879, Mr. Bright said:—“Home trade is bad, mainly, or entirely, because the harvests have been bad for several years. The remedy will come with more sunshine and better yield of land; without this, it cannot come. I believe the agricultural owners and occupiers of land have lost more than £150,000,000 through the great deficiency of the harvest.”

Since that time, more than 10 years have elapsed, but the remedy has not come. Sir James Caird estimated the loss to tenant farmers alone at £20,000,000 per annum, and the total loss to agricultural classes during the year 1885 at £42,800,000.

The amount of money thus lost to those markets, in which it was formerly spent and circulated, must have a very marked effect in the depression of trade generally.

Shipping operations also appear to have been carried on at a loss for many years, and all evidence concurs in representing a widespread depression of trade, from the workman's point of view, mainly in the increasing difficulty of obtaining employment or the prevalence of short time, but partly also in actual reduction of the rate of wages.

In fulfilment of Seyd's prediction, every possible attempt has been made to prove that the decline of commerce is due to all sorts of causes and irreconcilable matters.

The latter portion of the 19th century presents an extraordinary spectacle of retrogression. The functions of money have been degraded, and Europe has lapsed into the barbarous state of barter with silver-using countries. Apart from the evils caused by the contraction of currency, stands the falsification of this standard of money caused by the demonetisation of silver in Europe. Money is the standard by which we measure the value of commodities; and every standard of measurement, whether it be of length, capacity, weight, or value, should be as far as practicable incapable of variation. In a standard of length, “compensation” is employed to prevent variation; the most usual plan being the adoption of two metals so combined that the expansion or contraction of one metal counteracts that of the other.

Bimetallism is the method of compensating the standard of value; the two metals being so combined that the expansion or contraction in the relative value of one metal tends to counteract that of the other.

Gold and silver combined under the double standard of France, were, to all intents and purposes, the monetary standard of the whole world, until 1873, when the two metals, having been deprived of the compensatory action of the double standard, were subject to the most violent fluctuations.

The debts of the world incurred when gold and silver were equally the money of the world, have been estimated at about £7,000,000,000, and the standard of measurement of this enor-

mous sum has been suddenly falsified by legislative action.

The alteration in the standard of value is in principle similar to that which would occur by the adoption of false weights and measures. What would be thought of the honesty of a tradesman, who, by some device, would make his yard measure elastic, so as to contract by one third of its length; and this is what legislation has done to the standard of currency. There are many in the United States who accuse England and Germany of downright dishonesty in this matter. I do not agree with this view; the part England has taken is the result of ignorance and stupidity, and she has suffered more than any other nation from its effects.

Commerce is dead, and gambling has taken its place. The result of such instability and uncertainty as is shown in diagram No. 1 has had the effect of paralysing trade with silver-using countries, which forms the greater part of our commerce. Any sudden rise in silver is as disastrous as a sudden fall. It is stability of the standard that is required.

The absolute ratio in a bimetallic system of currency is of little consequence. Whatever ratio may be fixed by legislative action of the Great Powers must be stable and permanent, and it will be an advantage to adopt that which involves the least amount of inconvenience and change. But whatever alternative be adopted, it is evident that some measure for putting a end to this disgraceful state of affairs is urgently required. The situation is menacing, and any complication, either in commercial or political difficulties, or in unwise legislation, might suddenly give rise to a scramble for gold, which, to use the words of Mr. Goschen, might provoke one of the gravest crises ever undergone by commerce.

Indications of such a scramble loom ominously in the horizon. The proposed resumption of specie payment in Russia and Austria-Hungary, if carried out, will require an enormous amount of gold; and in introducing the Indian Budget last month, Sir David Barbour, the Finance Minister of India, held out a scarcely veiled threat that, if the United States of America should abandon silver as a monetary standard, India might, in self defence, have to close her mints to silver, and adopt a gold standard.

Such an action could not fail to produce a monetary crisis of the most appalling character, which would shake the credit of England to its very foundations; but, as Sir David has re-

marked "The adoption of a gold standard by India would probably be attended with very serious consequences for Western nations; but if in this matter they look only to what they conceive to be their own interest, they cannot reasonably object to India following the same course."

DISCUSSION.

Mr. R. MANUEL said he thought that the author attached too much importance to the influence of the currency on our trade; taking the aggregate of some of our imports and exports, specie played a very small part in it; we received goods from all parts of the world and paid for them by our own productions. The balance only being discharged in the precious metals. England also was a wealthy nation, and though she had a large national debt, it was not due to foreign creditors, and on the other hand she was a creditor for probably about 1,000 millions to other parts of the world, the interest on which also was received, not in specie, but in goods. He had heard papers in that room on this subject on several occasions; in 1876, when Ernest Seyd read an able paper; again in 1878, when there was one by Col. Smith; and again in 1885, when Mr. Maclean read a paper. It was an economic truth, admitted by all, that the cost of an article was the cost of its production, which in the case of general produce meant honest wages to the labourer, a fair profit to the farmer, and rent to the landlord; and no one would go on producing unless those three elements were provided for. If the product came from a foreign country, freight, insurance, and dock charges, &c., had to be added. He could not see how the mere fact that the value of that produce was expressed in one metal or another could affect its price in the market. He could understand a large silver-producing country like the United States being anxious to get 5s. an ounce for it rather than 3s. 8d., but he should like to hear what had been the effect on the people of India. As he understood, the value of the rupee, as a coin, had not much varied during all these fluctuations, but was still worth 2s. in labour or produce. India was a great trading community, and from a table in the year book of the London Chamber of Commerce, he saw that in 1888 she exported 92,000,000 and received 80,000,000. She was, therefore, entitled to collect from the rest of the world 12,000,000, and was probably paid in silver. If she got that at 3s. 8d. an ounce, and when it was coined it circulated at the value of 5s., he could not see how India suffered. On the other side, of course, India was very largely indebted, in a military sense, to this country, and the Council of India had to remit a revenue, paid in silver, to pay debts in England in gold, and also many gentlemen over there who received their emoluments in silver had to remit to England, and suffered a loss on the exchange. This was unfortunate for them, but he did not think

it was so important a matter as to warrant making the experiment suggested. With regard to the contention that a fall in prices was bad for the wage-earning class, he did not think that was sound doctrine; it certainly did not accord with what he learned from the late Leone Levi, that the tendency in England was for wages to rise and prices to fall, and according to Mr. Giffen that process was still going on. At present there was a tendency for labour to get more, and at the same time the necessities of life were nearly all cheaper than they were. He thought the matter should be very carefully considered before changing a system which seemed to have worked well.

Mr. J. EASTLY asked if the recent panic arose from scarcity of gold, or from locking up our resources in foreign countries. The 11 millions of notes issued by the Bank of England over and above the gold held in reserve was in consequence of a debt from the Government to the Bank, and the remedy would be for the Government to pay its debt, and so enable the Bank to meet the demands upon it.

Captain LODER SYMONDS said it was a very old argument that we did not pay in coin, but in goods, and that was quite true, and it would be very relevant if every transaction or contract were completed at the time it was entered into; then it would not matter what the values or prices were—whether a sheep were bought with an ounce or a drachm of gold; but, unfortunately, every contract extended over a certain period of time, and if the currency underwent alteration in the meantime, an injustice was done to one party or the other. In a mercantile community, therefore, it was of paramount importance to have a standard of value; and though they could not get an absolute standard as with weights and measures, Nature had provided two materials which had been used from the earliest times as representatives of value, and which, if used to supplement one another, to a great extent would prevent fluctuations in value. It was suggested that England, being an importing country, it was right to artificially enhance the standard of value, because in that way she got more than she bargained for; but that was worse than Shylock: he only wanted his pound of flesh; and this was insisting on the pound of flesh and the blood too. The only question was, would they get it? How about the rate of interest? What was the return on capital; was it always paid? What would it cost to exact the interest on gold bonds in Egypt, or from the Argentine Republic? If the threatened demonetisation of silver took place in Europe, he doubted if it could be got; and it certainly would not if silver were demonetised in America; and, if the same thing took place in India, it would mean the bankruptcy of 19 out of 20 of all the commercial firms in Europe. They all admitted that wages had risen and prices had fallen; but why? In England, during the present century, the powers of production had increased many thousand fold, and

the resulting increase was bound to go to the working classes. More goods had been made, and they could only be disposed of by distribution amongst the working classes. But what had happened since 1873? In his own experience, farming his own land, the wages of labour had fallen 30 per cent. He was now paying 9s. or 10s. a week to able-bodied men. If that was not due to the currency mischief, what was the cause of it? He had spent many years in India, and there the wages of agricultural labourers had not fallen, and in that country he had no difficulty in getting 8, 9 and 10 per cent. on investments, while in England you could not get 4 with safety. Why were silver-using countries prosperous, while gold-using countries were so burdened? The price of silver was more constant, and kept pretty level with the other commodities, while gold varied by jumps. It had been said that Europe had given its opinion, and had agreed to discard silver, and during the last fifteen years some steps had been taken in that direction; but during the last five or six years the set of opinion had been in the opposite direction, and educated opinion all over the world was now going back to the old customs of the past. The experience of the last fifteen years was not in favour of pure monometallism; in fact, such a thing as monometallism would be impossible. It would be found, in his opinion, absolutely necessary to go back to the use of both the metals nature had provided.

Mr. MARTIN WOOD said the discussion had gone on for many years, and he thought it was time the combatants came to closer quarters. Monometallists had hitherto refused to entertain the question except superficially, and on the other hand, the bimetallicists had been rather backward in recognising what would be the intermediate consequences of the change they advocated. Two or three years ago, he suggested to the Bimetallic League that they should draft a Bill, because until the matter was reduced to a practical shape it was difficult to say what the effect would be. The phrase international money was almost a contradiction in terms. You could have certain arrangements by treaty, but money, as he understood it, was fixed by an act of sovereignty in each country, and the metal when it left the country was simply a commodity. Sir Guilford Molesworth spoke of international trade being reduced to the barbarous idea of barter, but all economists knew that international trade was essentially barter. Any difference in the currency was taken into account, and it made no difference to the merchants engaged in the trade. If a change took place in the course of the transaction, of course there was a loss on one side or the other; but beyond that, currency did not enter into international trade. Bimetallicists were in the habit of attributing the fall in silver almost entirely to the action of France; but they omitted to notice that about the same time there was an immense increase in the Secretary of State's

drafts on India, and that was shown by Mr. Goschen's Committee, in 1876, to have had a much more important effect. Silver had depreciated in India, but the rupee had not. Prices had not risen because silver had not gone to India so largely as it would have done otherwise, on account of its importation being superseded by the issue of Council bills, which were sent out there, and thus the currency was contracted and prices prevented from rising. The great disturbing element in India's fiscal position was the annual export of from £12,000,000 or £14,000,000 to £20,000,000 sterling more than she received, bullion being reckoned on both sides. That was one of the most anomalous positions of any country in the world, and that, as Mr. Mill showed prophetically in his chapter on the precious metals, kept down prices.

MR. DANA HORTON said he was much gratified in being able to be present at this discussion, which was to him very encouraging. Reference had been made to a paper on the same subject by Mr. Ernest Seyd, in 1876, and it was about that time, or just before, that his attention was first called to the specie payments in the United States. In doing so he had to study the whole question, and derived much information from Mr. Seyd, as also from Mohl, of Wirtemberg. The great exemplar in the restoration of specie payments was England after the Napoleonic wars, and he had therefore to study the history of England in connection with money and the currency controversies of 1830-40, when the monetary system which England had since maintained was formed. His conviction was firm, and he could say so without any suspicion as to his motives, that it would be a good thing if the moneys of the British and Indian Empires were at par. He knew that most men in England had been brought up in a different school; but, as he said in 1876, he had confidence in the future, and in the ultimate settlement of this question on the right lines. This confidence was based on the manliness of Englishmen, and it had been strengthened by the tone of the paper and the discussion. He felt that opinion was changing, and he was quite sure that, though it might be a little hard at first, when they recognised that they had been mistaken, they would acknowledge it, and make the change which was imperatively demanded.

MR. MORETON FREWEN said he went to America some 12 years ago, just after the passing of the Bland Bill. He had just left Cambridge, thoroughly imbued with the doctrine of monometallism, having sat at the feet of Professor Fawcett, and, like many others, thinking that he had exhausted the truths of political economy. On arriving at Washington, he was very anxious to know how it was proposed to tie together two metals, whose value, as measured by their cost of production, was constantly varying. He inquired of many senators what the meaning of it was; and he thought the ideas he then imbibed were worth considering. It was pointed out to him that, in about 30 years from the discovery of America, and

the great inflow to Europe of silver from the mines of Potosi, all prices, wages included, rose from 400 to 450 per cent. As the Chairman had remarked, that vast rise of prices and wages was the great economic factor in the history of the Middle Ages. What would have been the position of Europe just after that phenomenal rise if silver had been violently demonetised, and the metal which had brought about this rise, and had been permitted free mintage, had been suddenly struck down. Would not all mortgagors and borrowers have been put at the mercy of their creditors, and all the industrious class of the community at the mercy of the less industrious section that lends idle money, by so sudden and so tremendous a depression of prices. The rise that had been brought about by silver must have been followed by a vast, sudden fall had silver been demonetised. Until 1873, every atom of silver and gold was admitted to free coinage in Europe, but since then a new system had been introduced by legislators; and he would ask anyone if the results had been satisfactory. The landed interest in this country is engulfed, and in America it was the same. In some agricultural States there had been a cessation of tax collection for fear of bankrupting the whole community. It had been suggested that the interest of America in this question arose from her silver mines, but the whole of the silver raised was not equal in value to the hens' eggs produced annually. The producers of a miserable £8,000,000 sterling of silver had not bribed two-thirds of the senators and congressmen at Washington, as was suggested in the *Times* in 1878, and these gratuitous suggestions, by the Press of England, of corruption, had done more to embitter the relations of the two countries than anything else. It was pointed out that the range of prices since the 15th century had been dictated by the amount of silver brought into the currency; the silver produced since 1873 had been refused free coinage in Europe, and the result was the currency was starved. One of the rankest heresies was the statement that international trade was "international barter." This was shown in the case of Egypt, a purely agricultural country, the fellaheen of which had to provide for the payment in London and Paris of the interest on a hundred million sterling, borrowed by the late Khedive Ismail to build a dozen palaces in Cairo. There were 5,000,000 acres of land and 6,000,000 cultivators, and when prices were depressed, as they had been immensely since the silver legislation of 1873, the cultivators of the Nile lands had to produce so much more to pay the interest. The export trade of Egypt is not paid for by imports, it is a direct sale for gold whenever it is to pay the charges of the Egyptian debt. Yet they were told this was an academic question, for our international trade was barter. Again, it was said that in India the value of silver had fallen, but the rupee remained unchanged. That was the whole crux of the silver question, and it covered the whole ground of the currency reform move-

ment. It was affirmed by economists of the old school that as the price of silver fell, more silver would be imported, resulting in an expansion of the currency and a rise of prices in India. Yet it was admitted on all hands that in India this had not happened. When he was in India he satisfied himself, and the figures had been amply confirmed by other writers that the wheat grower in the Punjab could afford to sell his wheat in Mark-lane at 22 rupees a quarter; now when the rupee was worth 2s., that would be equal to 44s. a quarter; but it followed that with the fall in the price of silver the price in Mark-lane must also fall. To day, if Indian wheat was sold for three half-sovereigns, those three half-sovereigns would exchange for 23 rupees; so that each fresh fall in the price of silver was necessarily followed by a fall in the English price of wheat. It made no difference to the Indian grower, who knew nothing about gold prices; but it made all the difference to the farmer in Dakota and Minnesota, and if the rupee fell to 1s. without losing its purchasing power in India, wheat would certainly be sold here for 21s. a quarter. That was the view taken of this question by the United States farmers, the best educated farmers in the world, and by other American producers. They believed that if the price of silver was good, a rational range of prices would obtain, and that money lenders and bankers would not make the immense profits of recent years out of the losses of the general community. It was hastily assumed that, because a government could not fix the ratio in value of sheep to bullocks as 2 to 1, the cost of production being very different, they could not fix a ratio between gold and silver. But unlike other commodities the price of gold and silver was not fixed by the cost of production. A United States Government Commission established that while the value of gold produced in California in 1854 was about £12,000,000, the cost of wages alone was more than £40,000,000; Jevons found that in Australia the cost of production of gold was three times its value; that the production of gold was £5 per miner, monthly, while miners were paid £13 a month; and everyone in the United States who had studied the subject admitted that the cost of producing £8,000,000 of silver was at least £21,000,000 a year. Under such conditions the two metals might be rated at 1 to 10, 1 to 15, or 1 to 20, and there would still be no such preponderating profit on one or the other which would prevent the other being produced. It was not the economic result, but the gambling fever, which led to gold and silver mining.

The CHAIRMAN said he should never have taken any real interest in this question, in spite of the many advantages which bimetalism would have in preventing fluctuations in value, if he had thought it would have any tendency to depress the condition of the great mass of the people. But he had

arrived at an exactly opposite conclusion. The theory was a most ingenious one, and very interesting, but he never concerned himself much about it, until he perceived that owing to the way in which silver was being proscribed in Europe since 1873, we were on the way to a great gold scarcity; as was put by Mr. Goschen, at Manchester, in 1887. The effect of this would be a steady, continuous, and rapidly-increasing fall in prices; because, if the cause was constant, the effect constantly increased in magnitude. In the case of a rise in price, the result was exactly the reverse; with a constant cause, the effect gradually diminished. Were they prepared to face the consequences of a fall in prices? An immense mass of evidence showed that such a fall would discourage enterprise of all kinds. Business men were generally borrowers; it was not their intention to have the weight of their debt increased, which was the effect of a fall in prices. This had been seen in Lancashire and elsewhere. The most vigorous support of bimetalism amongst the working classes came from Lancashire, where the people were well educated, and studied general trade matters, foreign as well as domestic. The ideal was to have the price of commodities kept as nearly as possible uniform, and the value of money stable: the natural condition of wages then would be to rise steadily. They were more likely to see prices falling, but wages remaining about the same, the men, at any rate, struggling to maintain their wages against a falling market; and that would give rise to a great deal of social and political disturbance. He would ask what was the alternative to the restoration of silver, for things could hardly remain as they were. Was silver to be retained as one of the monetary metals, or was there to be everywhere a gold standard? He did not believe there was a single statesman who was prepared to face the consequences of the latter proposal. At the Paris Conference, in 1889, there were many who did not agree with those who wished to give free coinage to silver, but no one, at any rate no one representing a Government, was prepared to accept pure gold monometallism. He was quite clear, in his own mind, as to the advantages of bimetalism; by that international money fluctuations in exchange with silver using countries would be got rid of; and what was still more important to the value of money would be more stable. Silver varied less than gold, and silver and gold together would vary less than either separately. They would also be relieved from the dread of a catastrophe, social and political, which would ensue from a continuous fall in prices.

Sir GUILFORD MOLESWORTH, in reply, said it had been recently stated, in a deputation to the Prime Minister, that wages were being continually forced down. Mr. Mawdsley and Mr. Kelley, who represented the working classes, had expressed the same opinion, Mr. Sewell Read said tenant farmers could only give low wages and scanty employment. With regard to Mr. Martin Wood's observation that the

phrase international money was almost a contradiction of terms, he would remark that within the limits in which bimetalism prevailed all gold and silver coins were international money; for example, five-shilling pieces could be bought for transmission to India, and recoined there without loss of value—since 1873 this could not be done. He wished to explain that the silver prices to which he had referred in his paper, and on which he had based his diagram Fig. 4, were not Indian prices, and consequently could not have been affected by Indian Council bills—the prices were based on Soetbeers index figures of the average prices of 100 Hamburg articles and 14 articles of British export. The opinion that silver had depreciated in India, whilst the rupee had not, was erroneous—the two had always kept together—in fact so long as the mintage of silver in India was unrestricted it was not possible that there would be any serious divergence in value between silver coin and silver bullion; in fact, it had been said, the test of international money was the melting pot. The question of the cost of production had been so fully dealt with that he need add nothing further.

The CHAIRMAN then proposed a vote of thanks to Sir Guilford Molesworth, which was carried unanimously and the proceedings terminated.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock :—

APRIL 29.—WILLIAM ROBINSON, "The Use of Petroleum in Prime Motors." PROF. SILVANUS P. THOMPSON, D.Sc., will preside.

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

APRIL 30.—COL. J. O. HASTED, R.E., "The Perriar Irrigation Project, Madras Presidency." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

LECTURE III.—APRIL 27.—Conventionalism—Necessities in the representation of facts with imperfect means—Reduction: *in relief* to flatness, and *in colour* to monochrome.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 27... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Hugh Stannus, "The Decorative Treatment of Natural Foliage." (Lecture III.)
Lantern Society, 20, Hanover-square, W., 8 p.m.
Mr. O. T. Bulkeley, "The West Indies."

Actuaries, Staple Inn-hall, Holborn, 7 p.m.
Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, APRIL 28...National Indian Association (at the HOUSE OF THE SOCIETY OF ARTS), 4½ p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 3 p.m.
Dr. E. E. Klein, "Bacteria: their Nature and Functions." (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. R. E. B. Crompton's paper, "The Cost of the Generation and Distribution of Electrical Energy."

Photographic, 5A, Pall-mall East, S.W., 8 p.m. (Technical Meeting.) Discussion on Animal Photography.

Anthropological, 3, Hanover-square, W. 8½ p.m.
1. Professor A. C. Haddon, "A Message Stick from Jardine River, and Notes on Queensland Natives." 2. Mr. H. Ling Roth, "Superstitions, Burial, and other Customs of the Natives of Borneo: from the Papers of the late Mr. Brooke Low."

WEDNESDAY, APRIL 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. William Robinson, "The Use of Petroleum in Prime Motors."

East India Association, Westminster Town-hall, S.W., 3 p.m. Mr. Charles L. Tupper, "Punjab Progress."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Annual Meeting.

Zoological, 3, Hanover-square, W., 4 p.m. Annual Meeting."

THURSDAY, APRIL 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Col. J. O. Hasted, R.E., "The Perriar Irrigation Project, Madras Presidency."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Camera Club, Charing-cross-road, W.C., 8½ p.m. Paper by Mr. J. Traill Taylor.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Recent Spectroscopic Investigation."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. 1. Professor Alexander B. W. Kennedy, "Research Committee on Marine-Engine Trials: Report upon Trial of the Steamer *Iona*." 2. Mr. Samuel Boswell, "Some Details in the Construction of Modern Lancashire Boilers."

FRIDAY, MAY 1...Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Paper and Discussion (continued).

United Service Inst., Whitehall-yard, 3 p.m. Major G. E. Malet, "The Late Royal Military Exhibition, and its Value from a Military Point of View."

Royal Institution, Albemarle-street, W., 5 p.m. Annual Meeting. 9 p.m., Mr. J. E. Harding, "Hawks and Hawking."

Geologist's Association, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover square, W.C., 8 p.m.

SATURDAY, MAY 2...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Silvanus Thompson, "The Dynamo." (Lecture IV.)

CORRECTION.—Page 436, col. 1, line 24 from bottom, *for 640 read 40*. Page 436, col. 1, line 6 from bottom, *for shale read formation*.

Journal of the Society of Arts.

No. 2,006. VOL. XXXIX.

FRIDAY, MAY 1, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third lecture of the course on "The Decorative Treatment of Natural Foliage" was delivered by Mr. HUGH STANNUS on Monday evening, 27th ult. The lecturer explained the meaning of conventionalism, and pointed out the varied treatment that was necessary according to the material treated. He went on to deal with reduction, and showed how foliage in relief could be reduced to flatness, and foliage in colour to monochrome.

The lectures will be printed in the *Journal* during the autumn recess.

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination will be held by W. ALEXANDER BARRETT, Mus. Doc., at the House of the Society of Arts, and will commence on Monday, the 1st June.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday evening, April 21st, 1891; Sir ALFRED LYALL, K.C.B., K.C.S.I., K.C.I.E., in the chair.

The paper read was —

SOME VICISSITUDES IN THE STORY OF CHINA.

BY SIR THOMAS WADE, G.C.M.G., K.C.B.

The Society, which has honoured me with an invitation to deliver before it a paper upon China, is formed for the encouragement of Arts, Manufactures, and Commerce; and it is natural that, in its desire for fresh information as to the method and degree in which these three conditions of material civilisation affect what may be termed an outlying province of the vast dominion thus claimed as within its jurisdiction the Society should address itself to some one whose connection with the province in question might be supposed to qualify him to speak with authority upon the subjects indicated.

To those who look for anything like authoritative exposition in regard to these subjects at my hands, my paper, I am bound to give notice, will prove a disappointment. The Chinese were wont to describe their community, long ages since, as consisting of Scholars, Agriculturists, Mechanics, and Merchants; and the pen of the first of these four classes having been abundantly exercised upon all matters pertaining to the vocations of the rest, it might be thought not impossible to produce from their works an essay that would exactly satisfy the special requirements of the Society. Misled by certain circumstances, to which it is not necessary further to allude, it was only within the last few days that I became aware of the precise terms of the commission I had accepted; and in the paper I had been preparing I had, in effect, altogether ignored the practical purpose set forth in the title of the Society. Had I earlier understood the nature of my task, frankly, I should have declined it, as one beyond my competence to perform.

But I may say that were my fitness less open to dispute, were I better acquainted, that is, with the contents of the voluminous compendiums on which I should have to rely, I doubt that the result would greatly further the attainment of the practical object which this Society is instituted to advance. Study of such works as these, which a writer upon the arts and industries of China would have to consult, whether in the original* or in the invaluable *Mémoires* of the Romish missionaries of the last century, is interesting, nay

* See M. Stanislas Julien's *Industries anciennes et modernes de l'empire Chinois*: Paris, 1869.

indispensable, to the archæologist; but the scholar of more modern range, even when enabled to supplement this reading by contemporaneous testimony, will supply little that the western inquirer, possessed of the latest secrets of science, will not pronounce obsolete. There is hardly a need that has not been met, in elementary fashion, by Chinese ingenuity, but the credit of inventions conceded, development may be said to have halted at the threshold. Native arts and industries are in the main where they stood in far off antiquity. In some instances they have receded. I was about consequently to tear up my brief, when I was assured that, its prescriptions notwithstanding, the Society would not refuse my discourse a hearing; the less that in its records were to be found two papers upon Chinese history, the subject I had chosen, devoted, one by Monsieur Terrien de Lacouperie, to a period so early, and the other, by Mr. Boulger, to a period so late, that my lucubration might rank as in some sort connecting the beginning with the end. It was not designed, I may add, in the first instance for any such purpose as the present, but as ancillary to a statement of some considerations arising out of the discussion between Russia and China, when the latter claimed retrocession of Kuldja in 1880. It is not necessary here to explain the relation of the remarks I had formulated to the discussion in question, but I mention it as having suggested the historical sketch of which I am about to lay a portion before you, well, perhaps, to find an opportunity of requesting you to excuse the fragmentary and inconclusive character of the paper. It is simplest in most cases to recommence a structure from the foundation. I have resorted to the alternative process of partial reconstruction, and the symmetry of the edifice has suffered accordingly.

You shall be spared the heroic, the semi-heroic, and even the earlier portion of the historic age, that is, from the days of Noah, say, to the days of Pisistratus, the contemporary of Confucius; but I must ask leave to take you back for a moment to about B.C. 220, at which time the last of a long line, the ruler of the original Central State, a kingdom not more considerable in dimensions than one of the provinces of modern China proper, yet, in virtue of his divine commission as Son of Heaven, the accepted suzerain of the princes round him, was dethroned by one of these latter. The usurper, having possessed himself of the kingdom of the fallen sovereign, as well

as of the fiefs of his fellow vassals, six in number, proclaimed himself *hwang ti*, the august ruler. This highest of earthly titles, which we translate Emperor, no one before him had borne, and by sundry other of his acts he endeavoured to secure himself such a priority in all imaginable conditions, chronology included, as should justify his assumption of the prefix *shih*, or commencement. Shih Hwang Ti, the Beginner, is remembered for much that is great and for much that is evil. He slew the men of letters. He upset their ritual, and he burned their books, although he had mercy upon the literature of divination and medicine. But he welded together, for the first time, in one block, some three-fourths of that we now call China Proper; and he built the Great Wall, or connected together various existing works of the same kind, for the purpose of excluding the Huns and other nomads who, long before his day, had mightily oppressed the people of what are now the northern provinces of China, and against whom he had been, to a certain extent, successful in war.

His dynasty, which by obliteration of all trace of any dynasty antecedent, was itself to have endured for ever, lasted something less than twenty years. His wall, after twenty centuries, remains. It has been added to and modified at different times, especially towards the east, but the greater part of the useless chain of curtain and bastion that is still called the *wan li che'ng*, or fortification ten thousand *li* long, must be standing pretty nearly on the lines originally chalked out for it, extending from the Kia-yü Kwan on the west, till it touches, eastward, upon the home of the Manchu.

As a permanent defence the great rampart proved no more serviceable than similar bulwarks elsewhere have proved, when the energy of the unencumbered barbarian has had nothing to face it but a civilisation too much enamoured of peace to keep watchfully prepared for war; none the less embroiled, from generation to generation, in war, domestic or foreign. For some four hundred years from the date of the Wall's construction onward, you find little relief from vexation of the old type; not border forays alone, but frequently incursions far within the wall, the advance of the light-footed bands being stayed again and again by bribes, or by treaties concluded only to be broken, or by humiliating matrimonial alliances extorted by the invader sword in hand. The story of a lady demanded and surrendered,

made known to the English reader in Sir John Davis's translation of *The Sorrows of Han*, is one of the most pathetic in Chinese history.

The collapse of Shih Hwang Ti's descendant, B.C. 207, is followed immediately by a general subdivision of his splendid inheritance, until the fragments unite again under the Han, a dynasty whose memory is still dear to the nation. Some four-fifths of modern Chinese know themselves by no other name than that of Men of Han. Its frontier troubles are never ending all the same, and although here and there are recorded extraordinary achievements, such as, in A.D. 94, its subjugation of all the states between China and a great sea far west, there is little of permanent peace along the border. To the philosopher the period is memorable, not only as witnessing the resuscitation of Confucianist literature, but also the introduction of Buddhism, by invitation, from India; and to the western historian, for its record of the first contact of China with a European power. Tribute, we are told, was sent from the Antonines; which being interpreted means, most probably, that merchants brought their wares for sale from some Asiatic province of the Roman Empire.

On the demise of this Han dynasty in A.D. 220, succeeds a period as distinguished in romance as in history, that of the Three States or Kingdoms, one of which is but the wretched remains of the Han; all to be superseded, half a century later, by the Chin or Tsin, which starts at least as sovereign of the entire empire. But this pretension is allowed a very short lease. The dynasty endures after a sort till the beginning of the 5th century, while, side by side with it are to be noted sixteen or seventeen minor powers, not contemporaneous nor co-ordinate, many of them bearing outlandish names of Huns or Turks, who have paid tribute to China in earlier days, or who have intermarried with the families of her emperors. These may be said, in general, to devour each other with tolerable expedition, until, on the confines of the fourth and fifth centuries, we come to the historical partition of China into two sets or empires, one north and the other south of the Great River.

The first dynasty of the latter, styled Sung, holding its court at Nanking, then Kien-kang, is followed in quick succession by four others. The former, founded by a native of what would now be called Inner Mongolia, the name of whose clan was Toba, came into life as the

Wei.* This fixed its head-quarters in Shan Si, at or near the modern Ta-t'ung Fu. The relative position of the two capitals should not be overlooked, for the first stands on the southern shore of the Great River Yang-tzu, while the latter lies away to the north, upon the southern edge of Mongolia.

I am contemplating, mind, not an abstract of Chinese history, nor more than a notice, as brief as I can make it, of the ups and downs in that series of vicissitude that a Chinese literate would not fail to recall, when he learned that his Government was engaged with a foreign power in considering a question of frontier delimitation; and I shall abstain, as much as possible, from the introduction of Chinese names, whether of persons or places; these being, in my experience, as a rule, unacceptable to English ears. The styles of the dynasties are, I must confess, embarrassing, for the founders of these, whether great or small, up to the Mongolian conquest in the 13th century, had a fancy for reviving the styles of dynasties bygone; and, although they may be distinguished as anterior and posterior, eastern and western, or otherwise, the foreign reader often gets as bewildered as if, in our own comparatively circumscribed field, he had to deal with two or three Tudor families, and four or five lines of Stuarts.

But I specially produce the name of Toba, as being that of the first barbarian, or say alien, imperial family, that established itself in China on a grand scale, and with a certain promise of stability; of minor barbarian trespassers there have been enough and to spare. There are points of resemblance too, worth noting between the rise of the Toba and that of the Gioro, the Manchu house now on the throne; though the latter go farther in pretension. In the first place, the Gioro boast themselves divine *ab ovo*. A heaven-born damsel was bathing in the Lake Purhuli, near Baikal;

"She said no shepherd sought her side,
No hunter's hand her snood untied;"

but a magpie, presumably from the spirit-world, placed a fruit in the sleeve of her dress, having eaten of which she became the mother of a son. This was Aisin Gioro, ancestor of the Manchu.

The To-ba did not begin quite so ambitiously; but they claimed as their progenitor one of the civilising patriarchs of ancient China, who, if not, as the profane insinuate, a myth, was at

* Lasting as Northern, Western, and Eastern Wei from A.D. 368 to 584.

the least, as we count time, an antediluvian, senior by some centuries to Noah; while several generations later his descendant, the then head of the house, also falls in with a lady, also heaven-born, in a wood; and we have thereupon a tale of mysterious lineage, that reminds us of the parentage of the pious Æneas, or of the twins of Rome. The patriarch ancestor, after all only a centenarian, whom I cannot bring myself to believe wholly mythic, had assigned one of his many sons a tract of country far north, in or about the Sien-pi mountains, where his tribe grew to be a mighty and marauding horde, named as of that ilk, Sien-pi. It was by these Sien-pi, the reader of Gibbon will remember, that the Huns were eventually overwhelmed. The syllables To-ba were said to represent, in the local dialect of the horde, the words forming the Chinese title of the royal antediluvian.

The particular To-ba by whom the house of Wei was raised, was one of the So-t'ou, a clan of the Sien-pi horde, who, besides having become the over-lord of several other clans or tribes, was also prince of one of the petty principalities—Turk, Hun, Chinese, or other—then dispersed sporadically about the north of the empire, where, thanks to this incessant border warfare, there had come to be a considerable mingling of barbarian and civilised, that is Chinese, blood. Like the great Manchu in later times, this To-ba prince maintained his ascendancy, northwards, over the savage hosts in his rear; and he organised them by the introduction of institutions copied from the Chinese. At the same time he extended his dominions in China, far south of the Yellow River.

A fact specially to be remembered in the career of his dynasty, is the inclusion among its subjects, towards the end of the 5th century, of the K'itan, a savage race, who were one day to run a course upon much the same lines as the To-ba's own. Furious wars meantime were waged all through its term; third or fourth-rate rivals, Chinese and barbarian, sprouted and died, one might say, within its bounds; and the Northern Wei, as, in contradistinction to its contemporaries south of the Great River, the chronicler names it, had never an easy time of it. Yet it outlived three of these Chinese contemporaries, and held its own for a century and a half, until it was subdivided, under pressure from other aliens, into Eastern and Western. Then at last its name disappeared without honour, in the old way; and then, after another of those weary intervals in which we

see, in uncertain light, some three or four competitors, the moribund and the newborn, each one styling himself *hwang ti*, august emperor, the Sui dynasty, in 581, once more collects the whole of China under one name; but this only to give place, after some forty years' sway, to a successor worthier than itself. The second of its few reigns we find distinguished by a certain meteoric brilliancy, but none in Chinese history, perhaps, has been more infamous for its license and its cruelty. In 618, the fourth and last of the Sui abdicated in favour of a victorious general, the first emperor of the T'ang.

Throughout the greater portion of the period so far skimmed over, Central-Asian enemies of many denominations, most frequently Turks, of whom in particular the Chinese speak as a species of Hun, have been disquieting the west of the empire. The tide of fortune, it is true, has not invariably set one way. China, at intervals, has asserted herself. She has planted military colonies, and stationed garrisons, for the time being, at least, in the wild west; far west of what is in our day her New Dominion. Barbarian chiefs have from time to time humbled themselves before her; have petitioned their sovereigns to accept their tribute and their homage at court, to enrol them as vassals of China, and in the capacity of their suzerain to confer investiture upon them, as khans or otherwise.

Indeed, in the second reign of the T'ang, a special grand success is achieved. This exceptionally glorious dynasty was represented, in 631, by T'ai Tsung, an exceptionally meritorious representative. In the above year, the fourth of his reign, the khans and princes of all the hordes unite in requesting T'ai Tsung to style himself their *t'ien khan*, Celestial Prince. He hesitates, not that he holds his desert unmeritable, but because, being *t'ien tzu*, the Son of Heaven, and emperor of the great house of T'ang, he doubts whether he can dub himself a khan without derogation. On the remonstrance of his ministers, however, he yields, and upon the seal affixed by him to documents affecting his new dependents, the *t'ien khan* is so described according to their prayer.

They are spoken of, these dependents, as the tribes of all denominations, or from the four points of the compass, and their act of submission, which was voluntary, might have been deemed at first sight a surer pledge of tranquillity than the Great Wall, that fence of art devised by Shih Hwang Ti. The nations

around brought gifts, and the bounds of the realm were enlarged beyond precedent, southwards, even into the Malayan Peninsula. The population of Kwang-Tung and Kwang-Si still call themselves Men of T'ang, in memory of a radical change in their organisation effected by the father of T'ai Tsung.

There is, nevertheless, a liberal allowance of war with the western Turk, and, farther west, the Uigur Turk, even during the remaining years of T'ai Tsung's reign, and, later on, with these races, and, to the north, with the Khitan, and with others, until, in 907, the dynasty decayed, falls to pieces. It had been in many ways glorious, not more because of its exhibition of material power, which was fitful, nor even of the moral influence by which in its best days it had impressed all barbarians far and near, than for its accomplishments in literature; for the age of the T'ang is the Augustan age of China. But the government has passed into the hands of the eunuchs, and when at length, in defiance of the court, their influence was nullified with oriental thoroughness, it was too late. The country was swarming with banditti. One of the chiefs of these is taken into the imperial service, and the state edifice is laid low and reconstructed with a summariness worthy of the Prætorian Guards.

Among the events which made the T'ang remarkable, there are two eminently noteworthy. One is the affirmation of the system of literary examinations; not its introduction; for examinations were of older date. So long as instruction was limited inviolably to the ancient moral teachings of China, it cannot be denied that the empire has been largely benefited by this system. The other incident, which in a country so moralised by Confucian traditions is scarcely credible, is the regency of the Empress Wu, one of the ladies of the harem of the great T'ai Tsung. She was taken to wife after he died by his son and successor, upon whose death, in 684, she imprisoned his heir, and usurping the supreme power, ruled with rigorous ruthlessness for some twenty years. She has given female regencies in China a disastrously bad name.

I should be glad to mend my pace a little, but for some distance onward the dynastic tangle is more involved than ever. For before the T'ang were fairly laid in the dust, in 906, there had cropped up a thick growth of mushroom independencies, each at the lowest a principality, all scrambling for a share of the great estate; and on the heels of the glorious house there followed besides, in quick succes-

sion, a series of dynastic houses known to China as the Five Minor Dynasties, that were anything but glorious. Three of them were founded by Turks, or other foreigners, and all so absurdly short-lived, that one can hardly understand how they ever came to be rated as holding the commission of Heaven at all. They stand on the roll of the twenty-four regular dynasties, nevertheless, numbering, as we number them, from the fourteenth to the eighteenth inclusive. The whole five exist but fifty-two years altogether, and then the last of them makes way, in 959, for the Sung, not the first dynasty so styled, but the more illustrious of that style, which continues, though diminished and diminishing in estate, to give emperors to China until it finally succumbs before the grandson of the grandson of Jenghis Khan in 1279.

But this is to anticipate. The Sung, as I have implied, were never masters of all China proper, and for just half their time they governed, at their best, but the southern half of the empire. Their first head, a soldier who had served the last five of the little dynasties just disposed of, in war against the Khi-tan, found himself, when greatness was thrust upon him by his troops, face to face with a frontier trouble painfully resembling that which had confronted that earlier Chinese dynasty (of the same name, Sung, but in no way connected with it), whose imperial claims had been so rudely withstood by the alien To-ba in 420.

The To-ba, you will not have forgotten, had towards the end of the fifth century accepted the allegiance of the K'i-tan, or Khi-tan, otherwise Khi-t'ai. To do justice to the doubtful aspirate in the second syllable of this latter variation of the name, western scholars came to write Khi-thai. Thence it drifted into Kathay or Cathay, which of course came to be pronounced in England as Englishmen are ever fearless to pronounce similar combinations. In Chinese the name of this people reads Khitan, or Sie-tan; or, in the north, Ch'i-tan. It was through the Khitan, probably when their country and Russia were overborne by the Mongol, that China first became known to the Russians. They still speak of the Chinese as the Kitaiski, while the Mongols call them Kitat.

Their alleged birthplace, as one of many tribes, was the land watered by the Liao river, which debouches in the gulf of Liao-tung (the country east of the Liao), where they had themselves suffered much, in early times, at the hands of the Hun proper; and later, from

the violence of the To-ba, who, not yet imperial, have been spoken of as passing through a Hunnish phase of savagery; nor did they make tender of their allegiance to the To-ba ruler, when emperor, until reduced by him almost to nonentity. There had already been, at uncertain dates, divisions amongst them, and emigrations; but, pure or hybrid, they reappear under the T'ang, and so plague that house, that, at the end of the seventh century, we find it entreating a Turki khan of might to co-operate with it against them. The khan's conditions are onerous; he exacts tremendous subsidies; he must also have a princess to wife. All that he demands is promised, and he takes the field against the Khi-tan, who collapse for the time, but revive again to be a thorn in the side of T'ang some forty years later. The T'ang get the better of them at first, in fair fight. Then follow negotiations, treachery, rupture, assassinations, until, as the safest policy, the emperor of the T'ang consents to recognise as khan of the Khi-tan the murderer of a khan who had just received investiture from the said emperor. For one of the recurring contradictions of this joyless narrative is the profession, and, to a certain extent, the reality, of feudal subordination to the Son of Heaven as suzerain, coincident revolts and wars notwithstanding. From the act of condescension just referred to, it is plain that the T'ang are no longer the T'ang of the days of T'ai Tsung.

I have picked out these details, as legitimate testimony in the case with which I originally had in view to deal; but I do not deem it necessary to trace in detail the career of the Khi-tan, under new names or old, from the date of the above incident, about the year 750, until their attainment of a serious political status, about the beginning of the tenth century. Remember always that their whereabouts are to the north and south of China proper.

Originally eight tribes, of a far larger nationality, they had separated themselves from this, and had adopted a federal constitution of republican or oligarchical character, under which the chiefs or elders of these eight tribes were used, turn and turn about, to elect one of their own number to the office of prince or king for three years. One of these presidents, or archons, by name Yélü or Yélat Apaoki, whose forefathers, taking advantage of the difficulties of the expiring T'ang, had annexed much T'ang territory, had refused to vacate the presidency when his triennial term of office expired, and so had brought the

other seven confederate tribes down upon him. Unable for the time to hold his ground, about the end of the ninth century, he withdrew his tribe from the confederacy to the territory that had been taken from the Chinese, where he grew and prospered. As soon as he was strong enough, he absorbed the common domain of the seven rivals who had constitutionally opposed his perpetual dictatorship, and, in 916, he assumed the title of *hwang ti*, as the first emperor of a dynasty which he styled Liao, after the fatherland of the race.

By annexing the possessions of other tribes, and of Turki and Nü-chin, the latter a people to be one day as eminent as the Khi-tan themselves, and more Chinese territory as well, the Liao had already acquired an estate far from contemptible when, in 936, the son of Apaoki was invited by a northern borderer of untraceable pedigree, some say a barbarian, who was ambitious of setting up as a head of a dynastic house, to suppress the second of the Five Minor Dynasties, in order that he might himself found the third. This aspirant, from whose hand, however, the prize was snatched away almost as rapidly as it had been won for him, had, during his short reign, repaid the Liao champion, on demand, for his king-making service, by the concession of a monstrous section of north-eastern China; and when in 961, the great Sung, whose advent to power has just been mentioned, replaced the fifth and last of these ephemeral pigmies, as the divinely commissioned, the Liao had been for some years at home in Yen, the present district of Pe-king, but then only distinguished as Nan-king, their southern capital; for they had, in Liao-tung and elsewhere, no fewer than five "kings," or centres of imperial government.

The court of the Sung meanwhile was fixed, perforce, at Pien, the modern K'ai-fung-Fu, on the south bank of the Yellow River. It has later to content itself with a residence in a much lower latitude. The country north and east of the same Yellow River, now the province of Chih Li and Shan Si, was meantime governed by the Liao, whose rise in political respectability is farther attested by the fact that, in 975, missions were interchanged between them and the Sung. A treaty of peace was also negotiated, whether on the motion of the Chinese or the Khi-tan dynasty, historians are not quite agreed.

As might have been anticipated, where there was so little of community of interest, indeed so much of diversity, there was no long con-

tinuance of friendly relations between the northern and southern courts. But the former, the Khi-tan or Liao, came gradually to pay, in a decline of manliness, the usual penalty of contact with a softening civilization, and in accordance with precedent, the supremacy which they had at first so haughtily asserted, is wrested from them by one of the rude nations whom, in their hardier youth, they had beaten and spoiled some two hundred years before.

The avengers were the Nü-chin, or Nü-chih. There are some half-dozen variations of their name. In countries without an alphabet the correctness of a nomenclature transmitted through the languages of others can never be guaranteed. The second syllable of Nü-chin was once changed to Nü-chih, for reasons prescribed by Chinese etiquette which I shall elsewhere have to explain. In Chinese history the older form is nevertheless retained. If their pedigree is not to be rejected, and we must think twice ere we reject it, they had descended from the Su-shin, a people reputed to have dwelt, it must have been while Troy was still standing, to the east of the Liao country and to the north of Corea. But they are eminently important as the acknowledged progenitors of the Manchu; that is, humanly speaking, for the Manchu ancestress, we must not forget, was a divine personage; and they were now about to do to the Khi-tan or Liao, not so much what the Liao had done to the earlier Sung (whom they only forestalled in part), as what the Manchu reigning at this moment was hereafter to do to the Ming, when the latter were expelled root and branch in 1644.

The rise of the Nü-chin to greatness, after their subjugation by the Liao, however, is not altogether dissimilar from that of the Liao themselves. The latter, although in their day of conquest they broke up the Nü-chin kingdom of Pei-hai, had not succeeded in extending their authority over more than a portion of its people. The rest, wild tribes unreclaimed—crude, or unripe, the Chinese call them—who spread up to and beyond the Saghaliyan Ula, or Black River (the Amur), had established tributary relations with the Chinese Sung which excited the jealousy of the Khi-tan; and some time elapsed before the latter succeeded in obliging the unreclaimed Nü-chin to bring tribute to them as Liao, and to take no more tribute to the Chinese. They then made use of the Nü-chin as soldiers, so distributing them in garrison that their separate nationality might in time be effaced.

Towards the end of the eleventh century, however, arose a Nü-chin, by name Yangko, the brother of their hereditary chief, who had the genius to provide his people with an organisation, civil and military; and, in 1102, the energy of the Liao being already on the wane, this man was applied to by the then emperor of the Liao to put down a rebellion for him. He consented to lend his aid, and detached a Nü-chin warrior, Okuta by name, to do the work of the Liao; Okuta having seen through the weakness of the Liao, very shortly turned upon them on his own account. In 1115, he had got so far as to assert himself emperor of a distinct dynasty, which he dubbed the Kin (the Golden), and, in 1117, he demanded that this, the Kin, should be recognised by his late employers, the Liao. In 1118, his new dynasty was so recognised by the Sung, who were dying to expel the Liao from the north of China, no matter by what means. and expelled they came to be in 1124 by the Sung and the Kin, who, *ad hoc*, joined hands.

There had been previously understandings between the Sung and the Kin, neutralised by supervening agreements between the Kin and the Liao; and the principality or kingdom of Hia, a half Tartar state of respectable seniority,* holding land to the west of the Chinese dominions of the Liao, also takes part, fatally for itself, in the wars and diplomatic contests of the period. In was in the land of Hia that the fugitive emperor of the Liao, when expelled by the Kin, took refuge. But its end was not yet.

At the date we have reached, we find the Sung, though the recognised holders of the divine commission, and with the wealthier provinces of the empire at their back, unable to recover from the intruding Liao the territory of which the latter had possessed themselves, when invited by a dynasty to support it in war; and yet with this lesson before them, about to repeat the very policy that had subjected China to the encroachments so mortifying to her national pride. They had been warned by the Coreans that the little finger of the Nü-chin would prove thicker than the loins of the Liao; but they were set upon present vengeance, and the sequel was what might have been looked for. At the instance of the Sung, the Nü-chin advanced against the Liao from the east. The Sung were to have made a corresponding movement on the west. But the Sung were slow, and, in a few words, the Nü-chin having

* They are first heard of in the 5th century, but figure as a polity towards the end of the 10th.

once laid hands upon the Chinese dominions of the Liao, refused to surrender them to the Sung. In their dealings with the Sung their arrogance and rapacity exceeded all offence ever charged against the Liao, until, in 1127, we find them marching off homeward with two emperors of the Sung, father and son, who having submissively entered the camp of their enemy at his bidding, have been detained. Charles IV. and Ferdinand of Spain are at Bayonne. The son and brother of the captives, accepted in their default by their subjects as Son of Heaven, flies south; his capital, K'ai-fung-Fu, on the Yellow river, is abandoned, and the court of his discredited family, thenceforth distinguished in chronology as the Nan Sung, or Southern Sung, drifts south, and after more than one trial of a resting place, finally halts at Hang-chau Fu, in Cheh-Kiang, in 1129. To how low a point of degeneracy the house had fallen is shown by its avowal, somewhat later, of the alarm it felt at the attitude of the king of Corea. There was still, however, a century and a half of historical existence remaining to it; but we will pass summarily to the great crisis.

The Nü-chin or Kin, with Yen—that is, speaking loosely, Peking—as their Chinese metropolis, had imposed themselves, at the same time, as sovereigns upon tribes and nations whom they had conquered or overawed in countries now vaguely described as Manchuria and Mongolia; and, if at first as brutally dictatorial as man in general when he emerges from barbarism, they had early discovered a taste for Chinese cultivation. Their poets, some of whom were emperors of the Kin, are not without honour among native votaries of the *Musa Sinica*. But an old tale repeats itself. The Goth civilised is no match for the warlike Moor. As in the case of the Liao, and scores of other *ci-devant* barbarians, the acquirement of the graces of gentle life proved to be, politically, not without its drawback. Subjects such as theirs could only be kept in hand, and enemies restrained, so long as the Kin were feared, and this they had ceased to be. In 1214, even the infirm Sung nerve themselves to refuse any more to send the Kin their annual tribute of manufactured silks, exacted long, and on an increasing scale. Early in the same year, the Mongol, once their subject, and at the moment their confederate in war against other Tartars, but with whom they have now for some time been at issue, has to be bribed, by the offer of a princess in marriage, to withdraw his demand for

surrender of their northern capital itself. And yet the humiliating peace thus concluded is so welcome to the emperor of the once fighting Kin, that he celebrates his humiliation by ordaining a general amnesty. But in the summer his capital, Peking, is none the less invested by the same Mongols, and in 1215, they are in occupation of the city.

They were but a corps of the mightiest host that mankind has seen in movement. In 1206, if not earlier, the great T'iemujin, whose headquarters were at Karakorum, on the banks of a river flowing from Mongolia, through modern Siberian territory, into Lake Baikal, had been proclaimed Jenghis Khan. In his less prosperous days he had a bird cry *tsingkis*, or something like it, and had accepted the circumstance as of good omen. This Robert Bruce-like legend is the Chinese explanation of his title, which, however, others say was assumed at the instance of the chiefs assembled, when he was first recognised as Khan, after important successes against his neighbours. The masses under his command were already sweeping, or about to sweep over Asia and eastern Europe, and in the tide of destruction the Kin, the Hia, and the Sung, the oppressor and the oppressed alike, were about to be engulfed; all to be lost in common subjection to Hu-pi-lai, the descendant of Jenghis, known to us, through Marco Polo, as Kublai.

The marvel, at first sight, is that the conquest even of the northern half of China by the Mongols was so long in completing. Some twenty years after they had entered Peking, we find them in co-operation with the Nan Sung, still fighting in the north against the Kin; but in 1235 the record of the latter in the chronological table is at last closed by the fatal formula, *Kin wang*. The Kin dynasty is extinct.

In the south, the Nan Sung found themselves as little advantaged by direction of their Mongol allies against the Nü-chin Kin, as they had been by their appeal to the Kin, in 1118, to recover for them the lands appropriated by the Khi-tan Liao; who again, let it be kept in mind, had themselves been set up, as Chinese proprietors, by a little dynasty that had requested their friendly offices in the deposition of another little dynasty in 936. From the demise of the Kin, in 1235, we have war with the Mongol and peace with the Mongol, and rebels against the Nan Sung making terms with the Mongol. At last Kublai is left master of the field; yet not altogether of his own act. I am tempted to tell the story of the demise of the Sung, not only

because it seems to me dramatically attractive, but on account of the light it throws upon the make of the Chinese mind political, formed as it was and is by its special method of education.

The Sung Dynasty, founded in 960, is held in name to have lasted 379 years, counting from first to last eighteen sovereigns. It was the tenth of these whom we saw driven south by the Liao Khi-tan in 1127; from which fact he is known as the first of the southern Sung, who in the end fixed on Hang-chou Fu, in Cheh-Kiang, as their capital.

In 1265, the fourteenth of the line, dying without issue, was succeeded by a nephew and adopted son, of middle age, but weak and debauched, who was entirely governed by an ambitious favourite, as debauched as himself, named Chia Ssu-tao. His confidence in this minister was at first unbounded, and Chia Ssu-tao, knowing how much his master loved pleasure, and how little he liked business, in order to keep himself in office, continued to conceal the internal wounds of the empire from him; speaking peace when there was no peace. The Mongols who, as early as 1260, had formally constituted themselves, in the north, a Chinese dynasty by the title of Yüen, were all the while steadily absorbing the southern empire, either by success in the field, or by the defection of Chinese governors who had lost all faith in the Sung. Private reports subsequently opened the emperor's eyes, but he stood in too great awe of his false servant to dismiss him.

In 1275, this feeble ruler died, and was canonised as Tu Tsung, under which designation he figures in the native chronicle. All emperors of China, when deceased, are canonised, and it is by their posthumous title that their shades are addressed, when, at stated periods, they are sacrificed to; and that, in history, they are personally designated after death. The posthumous title, nowadays, epitomises the imputed qualities of the deceased. Thus the old emperor who was reigning at the time of our first war, 1839-42, was canonised as Ch'eng, complete or completed, in honour of his assiduity. His son is adored as Wên, the accomplished; he was certainly not assiduous. The words to be chosen for these titles, and their applications, are enumerated in the statute. During life, once a reign commences, the name until then borne by an emperor should be no more uttered; and the written character representing it undergoes a change. Hence it was

that Nü-chin became Nü chih, because the character representing the latter syllable *chin* had formed part of an imperial name. The Chinese speak of events as happening in such a year of a regnal period, and we foreigners use the style of the reign as though it were the name of the sovereign. This is technically an error, and in former days would have been misleading, as these regnal styles were often changed for luck several times in a reign. In the last five hundred years, however, one regnal style has almost always sufficed for one reign, and it produces no confusion if we speak of the Emperor Kien Lung, grandfather of the Emperor Tao Kuang, &c. The Chinese do so use the regnal style, but, grammatically, as the attributive of the *ta huang ti* understood.

The Emperor of the Sung, canonised as Tu Tsung, had left more sons than one, and Chia Ssu-tao, in spite of the opposition of all the rest of the administration, contrived to place the younger son, a child of four years old, upon the vacant throne, with the empress dowager as regent. The Yüan, who had continued to advance southwards, having possessed themselves of a large part of the valley of the Great River, the Sung actually stooped to propose that they, the Sung, should become the tribute-paying vassals of the invader. But the Yüan, who had at first desired not to extinguish the Sung, were beginning to feel that the whole would be better than the half. They had besides no little reason for mistrusting the good faith of the Sung. The negotiations therefore broke down, and Chia Ssu-tao, who was with the army, wrote to urge the empress dowager to take to her ships. She refused, but in the course of a few months, the execrated minister having been in the meantime murdered, to the satisfaction of everyone, the lady, as she found her armies beaten, and her servants many of them changing sides, prepared herself to become even less than a vassal, and despatched a high officer to the Yüan general, already at the gates of her capital, with a tender, out and out, of her allegiance as a subject! She had been brought to consent, a short time before, to the removal of the court by sea, but, in a fit of anger, had delayed it too long. Two of the princes of the family, however, had been allowed by her to repair to different points of the coast.

The empress surrendered, as above, in 1277. On the receipt of a second message from her, the Mongol general sent off an officer with the

seal of the empire, which she had forwarded to him for transmission to Kublai Khan, who was then at Shang-tu, beyond the Great Wall; and thither, after having first prostrated themselves as subjects of the Yüan, were now escorted the empress dowager and her infant son, who was made, on his arrival at Shang-tu, a member of the Yüan noblesse. In 1288, he was desired to take the habit of a Buddhist monk, and was sent to Thibet, where he died: one authority says by violence.

Some patriotic Chinese had raised a considerable force for the purpose of rescuing him, as he was journeying north, in 1277, and had made a gallant effort to that end. Modern Spain again. They were beaten; but the force accompanying the two princes earlier sent to the seaboard, carried on the war against the Yüan in the south, and the elder prince, a lad of eleven, was declared emperor in place of the child now in the hands of Kublai; Yang *t'ai-fei*, one of the wives of Tu Tsung, playing the empress-regent. But the Yüan were too strong upon land, and the young emperor, being compelled to put to sea, cruised wearily about the south-east coast, his fleet and the fleet of his enemy fighting when they met, with small advantage to the cause of the Sung, until the unhappy boy, tossed and terrified by storms, died, sick and worn out. He had, very early in his short reign, sent a mission to Kublai, praying that he, too, might become his subject, and his petition had not been rejected; but it was still under consideration at the time of his death.

And now, their sovereign being no more, although there was still a third brother living, his Chinese adherents would most of them have gone off, every man to his own home, but for the spirited remonstrance of Lu Siu-Fu, a staunch patriot of the ancient texture. "With a son of the Emperor Tu Tsung still living," said he; "what is this that we are about to do by him? It was held by the men of old that, while there was a battalion left and a square mile to feed it, the rights of things might be restored. Here we have an official establishment with all its posts filled, and an army several myriads strong. If heaven be not minded to cut off the Sung, why should not the Sung still be the State?"

Moved by which harangue, the ministers agreed that the surviving prince, only eight years old, should be enthroned. A force of 200,000 men—Chinese armies run rather to a Xerxes estimate—was still kept together near him by his able prime minister,

Chang Shih-chieh, who also acted as his generalissimo and high admiral. But notwithstanding the valour and forethought of this loyal adherent, in a campaign lasting some months, the Yüan continued, by force and fair words, to gain ground, and Chang's losses by death and defection, after a hard action fought off the coast, at no great distance from Hong Kong, were such that he was minded to carry off the emperor, whom he had for some months kept afloat, to a safer station; and he sent a small vessel alongside the imperial junk for that purpose. But this move was stoutly opposed by Lu Siu-fu, who did not believe in the speed of the vessel sent, and had fears that her crew might be bought over; in which case the emperor would be made prisoner, and so put to shame. On the other hand, escape from the enemy's fleet seemed scarcely possible. Lu Siu-fu accordingly, first of all, drove his own wife and children into the sea; then, accosting his sovereign, he said, "The condition of the empire having come to the present pass, it behoves your majesty to die for the empire. The dishonour which befel the emperor whose reign was Tê Yu (the infant brother carried away to Kublai Khan) was extreme. Such dishonour must not recur in the person of Your Majesty." And he thereupon took the imperial boy on his shoulders, and plunged into the waves with him. The officials present, a large multitude, all drowned themselves. So, as soon as she heard of what had happened, did the lady regent. Chang Shih-chieh, still hoping to find some other son of the house to fight for, had begged her to accept his escort, but she declined. In the course of a few days the sea was covered with corpses, history says 100,000, either of suicides or of men of the Sung fleet killed in battle.

Some soldiers of the Yüan, rifling the dead, came upon the body of a youth attired in a robe of imperial yellow, and attached to it an imperial seal, which they carried to their general. They were sent back to look for the wearer, that he might be royally buried, but were unable to identify him.

The general Chang Shih-chieh's remnant of a fleet having been caught in a gale, he was urged to land, but refused. He had lent a hand, he said, when one of the Chao (the family surname of the Sung) had died, to set up another, and could he have found a third he would have done his best for him. Heaven had willed it otherwise. So having performed certain ceremonies, he too committed himself to the deep.

In our first war with China, 1839-42, we had experience of cases of devotion somewhat similar to the last, and I have heard the act of self-sacrifice derided by foreigners as evidence of weakness of mind. I shall explain below the native appreciation of like deeds under similar circumstances.

As to the other proceeding, the stern intervention of Lu Siu-fu, which of course a coroner's jury with us would characterise more severely, actions somewhat analogous may be found recorded by our own writers of history, without very marked condemnation. "Your father's son," said Claverhouse to a young cavalier who was making his way rather too hastily to the rear—his second offence—"your father's son is too good a man for the provost-marshal," and to save the delinquent from a halter, he shot him dead. We have tragic stories, too, which it is not necessary to recall more in detail, of the preference of death to dishonour by British men and women in the Indian Mutiny. *Requiescant!* If any man would judge them, may he never be exposed to a like temptation! But in Chinese eyes, suicide, in the case of an official, may be not only excusable, but highly praiseworthy. A public servant who resorts to suicide in plain dread of a responsibility of which he has made no fitting effort to acquit himself, is held, it is true, to deserve very serious reprobation. In 1856, a governor-general in Yün-Nan, who hung himself when the Mahometan rebels were approaching the provincial capital, yet before they came in sight of the walls, was refused posthumous honours by the emperor; a severe penalty. In a case such as that before us, the self-immolation we are not free to applaud would be viewed as the simple discharge of a duty. The Mirror of History, as edited by the great Emperor K'ien Lung himself, has the following marginal note on the incident under his own imperial hand:—

"Cheng Shih-chieh, when he secured his vessels stem to stern in the anchorage off the island [the scene of the action], had made up his mind that the fight must end fatally. Still, as he was enabled, after his force was utterly routed, to take himself out of the strait, and as the Princess Yang [the lady regent who drowned herself] also contrived to reach the sea, it cannot be said that there was no way of escape left. But what Lu Siu-fu specially apprehended was, that if he [the emperor] should succeed in getting away, the last pang would be delayed only for the moment: in the end he would inevitably be taken. For this reason he did not flinch from carry-

ing the emperor with him into the sea. Herein was discharged the duty incumbent on ruler and minister, to join together in dying for [or with] the gods of the land and grain.*

"And although the conception of Chang Shih-chieh was different, in so far as that he would have still continued to look for another of the family of Chao, yet the purity [literally, whiteness] of the two men's sentiments was the same."

Lu Siu-fu had more than once represented the Empress-dowager in the resultless negotiations with the Yüan earlier adverted to, by which China was to have become their vassal or dependent. Yet I do not find him blamed in history for the part he took therein. From his last speech to his young master it may be assumed that he drew a line between the position of tributary, which he was instructed to negotiate, and the lower level of humiliation to which the Empress and son descended when they yielded themselves to their conqueror as subjects.

Sung wang, the Sung were not, and the Yüan gathered the empire together once more as one; their capital in China being Khan Balik, the citadel or fortress of the Khan, the Cambalu of Marco Polo, within easy range of the site of modern Peking.

By the substitution of the latter for their predecessors the claim of China to be an independent power was more nearly extinguished than ever before or since; for although the Mongol *hwang ti* was as imperial in title as imperial designations could make him, she had fallen, had she known it, to be simply the largest of the grand divisions of a colossal family estate, the accumulations of Mongolian conquest extending from the Yellow Sea to the Adriatic, into Poland, and to the threshold of Russian princes, who travelled to Tartary to do homage to the Bogdo Khan, the *shêng chu*, or Sacred Lord, or Master, of Chinese terminology.

The repertory of this, where the sovereign's personality, qualities, functions, or whereabouts are concerned is, to our notions, at least exhaustive. The gods of Greece were not more *polyonymous*. Some of the combinations, such for instance as this one of *shêng chu*, place the ruler too nearly on a level with the Deity for our taste. The Manchus speak of him, in Chinese, simply as *chu*, lord or master. One form of appellation by which he is spoken of, or to, especially when acclaimed on state

* The *patrii lares*, abandonment of whom would have been similarly reprobated by the Roman patriot. See Lucan I. 506.

occasions, is *wan sui yé*, lord of ten thousand years. "O king live for ever."

But this second-rate position was not to last long, and for any temporary abatement of dignity China might sustain as the subject of an alien power, when the Sung left her helpless, the country may be said to have been for the moment—though for the moment only—compensated by the restoration of something like a strong government; a blessing to which it had been many years a stranger. Kublai, who had not only reigned but governed, was an energetic soldier and an able administrator, whose line, had his heirs been of the same stuff, might even now be rulers of the state of which he had restored the integrity. This they were not. They put away their simplicity. They became a divided house within; without, they filled posts with unworthy servants. They ignored Chinese principles and usages; they favoured heterodoxy; and their executive so outraged public feeling that, in 1368, their sentence of dismissal was pronounced, and they made way for the Chinese Ming.

But the Ming did not eject the Yüan by a *coup de main*. Even in these days of gunpowder, when the matchlock and wall-piece which have superseded the bow and arrow of Jenghis's campaigns were beginning to make way for arms of greater precision, the foreign importer of the latter, dispassionately abiding the outcome, has been witness, during the Tai P'ing rebellion, of operations so classically deliberate as to render the siege of Troy a perfectly imaginable occurrence. In the period of the great Khan, and for long after the toil and strife continuous of war was naturally less susceptible of curtailment. The Mongolians in their conquest of China had not carried all before them; but the invaders, recollect, were comparatively few, while the country to be absorbed by them was not far short of the area of Europe; besides, as I have said, it is doubtful whether, had they played their cards more honestly, the Sung would not have been allowed to retain a footing as a tributary state. The Ming re-conquest took more time than might have been expected, as the Ming were Chinese; but for this there was great excuse. The Yüan had left chaos behind them.

Forgive me if I dwell at some length upon the downcome of this departing Mongol family. I have more than one end to serve in so doing. In particular, the story of their demise, and of the reflections of the first of their successors

upon their fate, as told by the native annalist, is singularly illustrative of the Chinese moralist's conviction that an emperor is but the trustee of Heaven, an authority long-suffering, but sternly just; which if the blindness of its agent be so confirmed that its monitions remain unheeded, will surely rend his kingdom from him, and set another in his place. And there are some other lessons in the same chapter. I have, as usual, to hark back a few years.

In the last preceding section of our retrospect, the Mongols, after revolting from their sovereign lords the Kin, or Nü-chin, were seen combined for the nonce with the Nan Sung, against the said Kin, and the Kin expelled—retreating, really, before the Mongols into the Nü-chin country, north of Corea, from which they originally came, and from which, to the sorrow of the Ming, now about to replace the Mongolian, they are one day to return as Manchus. Meanwhile, the emperor of the Nan Sung, relieved as he hoped of the Kin, has discovered, like the horse in the fable, that in his recourse to a too able auxiliary, *il avait fait folie*. The Mongolians at once set about saddling and bridling their imbecile ally.

Still, powerful and ruthless as they were, the sceptre, as before observed, did not finally pass from the Chinese ruler until 1280; that is to say, that counting from the exit of the Kin in 1234, it cost the Mongolians over forty years of operations, not invariably successful, before they could pretend that they had built the house of Yüan and finished it.

And the construction, *tantæ molis*, was to expire of its own rapidly developed infirmity in little more than eighty years; declining, however, within this short measure of life, with the slowness generally characteristic of transformation in China, when the wand is committed to the hand of the Chinese. The Yüan dynasty, in fact, took full twenty years to die, if it be fair to say it died at all. You will see directly why I reserve this point. Its vigorous commencement notwithstanding, the close of its brief connection with China as a reigning family was remarkable for disorder of an extent and quality astounding, even in a land so painfully familiar with brigandage and civil war.

The Mongolians, I repeat, though earlier sworn in as Yüan, did not stand sure until the year 1281, and whatever their faults, it must be allowed that the fates, or, as the Chinese would say, an indignant heaven, were also

against them. For between the years 1313 and 1333, no fewer than eight sovereigns had occupied, or claimed to occupy, the throne; a change of mode sorely trying to the stability of any despotic government, even could it have boasted longer confirmation. In 1333, To-huan Timur, the last of this house that was still to rule in China, after some perilous plotting and counter-plotting, in which he was played with as a shuttlecock, succeeded to the throne. He reigned twenty-eight years; a poor creature to begin with, and his stars shone darkly over him. His term had barely commenced when plagues, terrible in degree but not preternatural in character, flights of locusts, dearth fatal to millions, earthquakes, and inundations, began to agitate the minds of the Chinese, already ill-disposed towards an alien government which had been steadily losing caste. These afflictions were signs; but there were wonders as well, reported and believed in, by which high heaven was uttering its warnings. The skies drizzled blood, and rained coloured plumes (or fine hair). Two suns were seen in collision. Growls, as of thunder, proceeded from a particular constellation. A plum-tree brought forth cucumbers.

Some of these portentous things were not impossibly natural phenomena, interpreted with the wisdom that stamps a blue-jacket's appreciation of sounds and sights in the modern heavens. Some, of course, were as possibly creations, pure and simple, either of the credulous or of the designing. Which ever they may have been, facts distorted or baseless fictions, a belief that the prodigies enumerated did so conjointly meet, and this to presage the impending chastisement of Heaven, began to reveal itself in disparaging rhymes and predictions; a form of *plebiscite* in China ever the harbinger of mischief where the government is weak or apathetic.

I shall submit to you here a free translation of certain comments of a native historiographer upon the true signification of the portents so taken note of by the multitude, as to the credibility of which he evidently entertains no doubt. I shall, at the same time, beg you to observe his obligations to a memorial presented B.C. 140 by a celebrated minister of the Han dynasty to his sovereign, who, at seventeen, was just commencing his reign. The young emperor in question was bent upon a measure, against which his minister, Tung Chung-shu by name, protested; and a reference to the chronicle in which his protest is

preserved shows that his objections, again, were suggested by a careful study of the Confucian canon known as Spring and Autumn; a skeleton history—very skeleton—of the philosopher's own state, compiled or revised by him some four centuries before.

I trouble you purposely with these dates of far-receding epochs, a converseance with the thought and action of which is the strong rock of Chinese conservatism. Confucius, who flourished five centuries before Christ, is studied, you will see, some three centuries later as the authority on principles of government by a statesman of the Han, whose opinions, inherited from Confucius, are quoted by a historian of the 17th century, in support of his own explanation of the failure of the Mongolian Yüan in the 13th. Language rather identical than analogous has been employed in addressing an emperor of China, on policy, in the present century; in fact, but a reign or two ago.

"Showers of blood," says my historian, writing about 1630, "and showers of hair) or feathers), are things so unusual that they must be accounted supernatural. We are told by Tung Tzu (Tung Chung-shu) that when the government (literally, the state-family) is straying from the right path, Heaven will first visit it with calamities extraordinary; that it may be reprov'd. If it have not the sense to awaken to its duty, Heaven will cause then to appear prodigies extraordinary; that it may be stricken with terror. If it still be without the sense to reform, and its demoralisation go so far that, although the ruler have before him this evidence of Heaven's desire to put an end to the disorder of the state, out of love for him,* he, alas! making light of its visitations, and reposing in unconcern, fearing nothing, and regarding what he should consider warnings of High Heaven as but trifles proper to the order of nature,—inquires not of Heaven by what means these evils may be averted; then, as day is piled on day, and month is linked to month, the wrath of Heaven and the resentment of the people grow to be such, that,

* Having used Tung Chung-shu's memorial thus far, the historian continues the passage in his own fashion, as I have given it. Tung Tzu, in a notice consecrated to him elsewhere, is shown to have gone on somewhat as follows:—"The evidence of Heaven's loving kindness afforded by these reiterated reprieves is not to be construed by the ruler as indicating a simple desire on the part of Heaven, when a generation has gone altogether off the right path, to lend him such support as will set him (or it, free from all anxiety; but to stimulate to exertion. One form of effort, study, will develop the intelligence; another, the effort to keep in the right path, will develop virtue, &c., &c."

until he be no more, there will be no end of either. Ah! when Heaven utters a warning, can it be that it shall say what is untrue?"

Untrue, or whatever other adjective we may select as translating the compound "unsubstantial and erroneous," or, "misleading." Parallels of the last sentence, which is literally rendered, will, of course, occur to any reader of Scripture. For a protest against irreverent depreciation of portents, we may fall back on more than one passage of Shakespeare.*

Scarcely less noteworthy, in my judgment, are the reflections of the first emperor of the Ming upon the death of the last of the Yüan, him to whom the above warnings had been sent; and upon the proposition of certain of his Chinese ministers that Maitilipali, grandson of the Yüan, who had just been taken prisoner, should be immolated sacrificially. This first of the line of Ming was originally an acolyte or servant in a Buddhist establishment; one of the two founders of dynasties, observes a Chinese, who had no antecedent dynastic pretensions; a self-made man. As one of the most admirable persons in Chinese history he well deserves the monograph with which he has been honoured by Abel Remusat.

The capture of Maitilipali was an incident in the ever-recurring frontier trouble. Against this the Chinese Ming, rehabilitated by their late emancipation, were for the time proving themselves competent to make head of their own strength. On occasion, they even showed that they were equal to assumption of the offensive; the surest pledge of a nation's independence; and thus it came that the young prince of the Yüan fell into their hands.

To return again to the demise of the Yüan. During their short tenure of Heaven's commission, from 1281 to 1368 only, they had not been altogether free from border wars, as for instance on the side of Burma; and they had been obliged at times to take action against enemies threatening Ho-lin, or Karakorum, the great centre of their race beyond the Shamo desert. They annexed Corea, and they had differences with Japan. They sent a huge fleet to exact tribute of Japan; which fleet, however, was all lost. Still, in their time, China Proper appears to have been comparatively exempt from disturbance on the land side; this immunity being no doubt partly due to the fact that the empire, though the chief division, was in a sense but a section of a huge Mongolian domain. On the other part, Mon-

golia proper was itself kept pretty busy by inter-necine wars.

But the Ming had no sooner driven the Mongol across the border, than we read of a recrudescence of the old border disease. Tohuan Timur had sneaked away ignominiously from Cambalu, in defiance of the prayers of his generals, who implored him with tears not to abandon what the prowess of his forbears had won for him. But he was no warrior, although it would seem something of a poet, and, in a sad farewell to China attributed to him, he pathetically bewails the loss of his crown as the penalty of his dreamy inertness.* His flight was not accepted by his Mongolians as synonymous with the extinction of his dynasty. It was assumed that this had only adjourned across the desert to its capital of Karakorum, and on the strength of this ill-affirmed title, it posed, dynastically, as the Northern Yüan.

Still it reigned no more in China, though her northern provinces were persistently worried by Mongol armies led by the son of the fugitive, or others, his commanders. In the third year of Hung Wu, the first reign of the Ming, 1371, a Chinese force moving upon a city held by the Mongols beyond the Great Wall, learned, from some prisoners taken *en route*, that Tohuan Timur was just dead, and, pushing on, captured nearly the whole Mongolian court; the heir of Tohuan Timur alone escaping. The seals of state, and other articles forming part of the imperial regalia of the Sung, which had become the prize of the Mongols in 1279, when they carried off two sovereigns of that dynasty, were now recaptured by the Chinese. Much other spoil was taken, with thousands of prisoners, sheep, and oxen, horses, and camels.

On receipt of the news, the official establishment, as one might expect, assembled in its full strength to offer its congratulations; but the emperor, out of delicacy, by special notice excused all public servants who had also held office under the Yüan dynasty, from attendance; and he himself selected the title by which his deceased predecessor should be canonised, and with his own hand drew up the elegiac composition which is read and burned at the burial of the dead.

The title by which he canonised Tohuan Timur was Shun Ti, the Obedient, or the Submissive; not by any means as patronising a foe worsted in the late fight, but because he had meekly bowed to Heaven's decree; because (in that he had fled before the Ming from his

* "Let not men say, these are their reasons; they are natural." Julius Cæsar, 1, 3.

* I quote Dr. Bushell, who quotes Col. Yule.

capital in 1368, without giving battle) he had shown that in the success of the Chinese he recognised the will of Heaven. Thus at least it will be seen that his retreat was understood by the conqueror who wrote his epitaph*, or whatever we prefer in English to call the paper in question. A strict translation of this would be scarcely intelligible without more of annotation than would be here endurable. Its sense is pretty much to the following effect:—

“That we be born or that we die, that a dynasty be put away or that it rise, is not the moment’s accident. It is the fulfilment of conditions fixed by the powers of creation (literally, of heaven and earth). Of the four Sages of antiquity, but one (Confucius) perhaps approached [infallibility so as] not to need to change. And why? Because he had attained such knowledge of the will of Heaven that he had no more doubts.

“Thy ancestors, Sovereign, were a people who rose long since in Sha-mo (the desert). Armed with bows and arrows, they invaded this Central Kingdom and overran the Empire. The nine I and the eight Mán (the barbarians of all denominations), submitted to them. Had Heaven not so willed it, this had not come to pass.

“It behoved Thy line, by adoption of change when needful, to maintain their hold of the state they had acquired; but there has been a chaos of violence (*lit.* robbery); the flowery land has been in sorrow; the laws have not been obeyed; and thus they have lost the State. Is this the doing of man, or the way (or wisdom) of Heaven?

“And so is it by nothing but the will of Heaven that *WE*, the Emperor, at such a moment, although without an imperial force at *OUR* command wherewith to inspire the Empire with awe, did yet replace Thee, Sovereign, and become the ruler of this people.

“In the immediate past, Thy home being in the Sha-mo [the desert], and *OURS* in the Central Kingdom, Thou and Thy ministers were resolute not to give place, and our borders have been many times disquieted with Thy troops. Yet now that *WE* are informed of Thy death in the Sha-mo, *WE* grieve. *WE* send a special messenger to mourn before Thy bier, and to pour a libation of wine as an offering to Thy spirit. Deign to bestow a glance upon it!”

The theory accepted by the imperial writer of the above deserves a word or two of explanation; but before touching on his philosophy we will dispose of another instance of his practice, which, it will be allowed, did him honour. A few weeks after the levée aforesaid, the prisoners arrived at the capital, and among them was Maitilipali, the young Mongolian prince whose sacrifice had been desired by the

emperor’s ministers. It had been also their wish formally to present the recovered regalia to the emperor in court. This compliment again he waived, directing that they should be simply deposited in the treasury. Then, as regarded the proposed sacrifice of the captive prince, he asked his advisers whether when the heroic dynasty of the Yin, otherwise the Shang, was overthrown (B.C. 1122), Wu Wang, its destroyer and successor, had done this thing? The ministers could not say that he had or that he had not; but they were ready with a more modern precedent: the founder of the T’ang had sacrificed an important prisoner, whom they named (A.D. 621). “Yes,” said the emperor, “for questionable acts; but he would probably not have so sacrificed a son or grandson of the Sui,” the dynasty deposed by him. Then, continuing, he observed that under the Yüan, in the time (something less than a century), that his ancestors and himself had dwelt in the Central State, they had shared with the generations which had grown up the benefits of peace, secured by the Yüan government. That it was true that in ancient times this bloody rite, performance of which his ministers were recommending, did exist, but that he could not bring himself to give effect to it. It would suffice if the prince Maitilipali were brought before him in his ordinary Tartar costume, and that, when a Chinese dress had been substituted for it, he should then return thanks for the favour shown him; in other words, do homage as a subject.

The emperor further acquainted the ministers that he did not intend to follow the rule on which the Yüan had acted, of introducing into the imperial harem the ladies of the fallen house. They were consequently presented at an audience, like the prince, and having exchanged their Tartar robes for Chinese apparel, were assigned a palace apart, while the young prince himself was created a Chinese noble of the second degree.

We naturally bethink us of Alexander’s treatment of the family of Darius, great and good. Chinese history is not without other examples of imperial magnanimity; not mere formal acts of condescension, but of benevolence certainly not to be discounted as prospective.

But the emperor’s personal qualities are, I admit, outside my case. His kindness, humanity, and sobriety, for all which virtues he was illustrious, come before us by the way only. What I am concerned with at this

* As this specimen shows, the composition might fairly be styled an *oraison funèbre*.

moment, in relation to our special subject, is his doctrine. Do not, pray, suppose that I meditate a disquisition on Chinese philosophy, *au grand complet*. Were I competent to inflict one upon you, this, I am aware, is not the place for it. I shall not alarm you, however, I hope, if I ask you to observe how interchangeable in the Chinese system of thought are the terms political and moral, and in what close, indeed indissoluble, alliance stand also the moral and material. The writings which the emperor evidently had in his mind, as he meditated on the lot of his vanquished predecessor, are accessible to any student of Chinese. They are of the stock of any native's education. If I did not misread those scriptures, when I wrote these lines some years ago, his postulates would have been something to the following effect:—The creation of all things, moral and material, is the work of Heaven and Earth, the dual powers of nature. There are principles of morality, cardinal virtues, which remain immutable; but, to enable systems to endure, they must be revised as occasion may demand, still, in such wise as not to unsteady the equipoise of the dual powers. The secret of this was mastered by Confucius at forty. Having very early applied his heart to seek out wisdom, the sage had no doubts as to how things ought to be. But it was not till he reached his fiftieth year that he had solved the problem of the *t'ien ming*, the decree, or declared will, of Heaven, to possess the secret of which, says the commentary, is to know the reason *why* things ought to be. Then he could err no more. The Yüan had come to rule China in fulfilment of Heaven's will. Their courses being evil and unreformed, Heaven gave their estate to another.

In a somewhat similar strain did Kang-Hi, the second Emperor of the Manchu, two centuries later, lament the fall of the dynasty founded by this very worthy patriot, who had wrenched the sceptre from the Mongolian invader. But because of the offences of his line, the Ming, the empire had been taken from them by High Heaven, and had been bestowed by Heaven on the Manchu; not on account of his merits, but as the instrument of the higher power. In the year 1850, when the reign of Hien Fêng was commencing, the new emperor, a lad of eighteen, was addressed by some fifty memorialists, on the state of the Empire. A large proportion of these state papers were of course homiletic, and in more than one these is this one condition of the stability of imperial rule insisted on, the

recognition by the sovereign of his responsibility to Heaven, and of the peril of neglecting its warnings. That the phraseology should be nearly uniform, the preachers being Confucianist, is not astonishing. But I must close. The story of the Ming, and of their Manchu successors, the Ts'ing, now reigning, even if summarised, would carry me far beyond the bounds of time assigned me, which, indeed, have perhaps been already overpassed.

DISCUSSION.

Professor DOUGLAS said they had had a most interesting and able sketch of the history of China, from ancient down to comparatively modern times, and one fact which had impressed him very much, and which must have been noticed by all students of Chinese history, was very well illustrated by it, namely, that although there were constant over-turning of empires and dynasties, those great revolutions had been accomplished with the least possible disturbance of the administrative machinery and discomfort to the inhabitants. Disturbances and revolutions which would leave a European country the victim of bloodshed and horrors for centuries, seemed to pass off in China within a comparatively short time. The reason probably was that the Chinese had no personal loyalty to the emperor. They knew him simply as an abstraction, representing law, order, and the Confucian tradition, and as long as those were preserved, every subject was content to obey. It was remarkable to see what slight changes in the personnel of the administration followed a change of dynasty. The mandarins holding offices of various degree, transferred their services to the new comer, and so while one dynasty or royal house succeeded another, the empire went steadily on. The Turkish, Mongolian, and Manchu dynasties had at various times occupied the throne, and had been looked upon by the inhabitants as almost their legitimate sovereigns. If at any future time a European conqueror were to make himself master of China, the people would probably submit to him as readily as they had to the Manchus, Mongols and Turks, always supposing that he followed the same policy of conformity and conciliation adopted by these Asiatic invaders.

Mr. FRANCIS COBB thought every one must admire the great erudition shown in this paper, and having had the honour of meeting Sir Thomas Wade in China, he only regretted that he had not been able to bring the history down to more recent date, for no one else was so competent to do so. He had passed through one of the most interesting periods of modern Chinese history; the Taeping rebellion, and he hoped at some future time he would continue the history he had now begun.

The CHAIRMAN said he also had been deeply interested in the paper. China was perhaps the oldest empire in the world, certainly the oldest continuous empire in Asia. But although it had passed through many vicissitudes, there are perhaps few things more remarkable in its history than the fact that a lecture on China should be delivered in London, that the British frontier should run for more than a thousand miles with the ancient empire, and England and China, nations so distant and so utterly dissimilar, should be friendly neighbours in Asia. Some of the references made would remind the auditors of matters they had read in English literature. Kubla Khan was the great emperor visited by Marco Polo, the first to throw any light on the vast empire; and his name occurred in the beautiful lines of Coleridge. In going through the history of China, one constantly caught glimpses in this way of matters elsewhere alluded to, but which were now brought forward in greater completeness. The curious phenomena of a sacred ancestor to a family was known in Greece and Rome; in fact, all great ancient families went back to some myth of the kind. They also heard of the female regency, which in Asia generally had a peculiar form and character, for at any rate, in India and China, female sovereigns always had a very short and sharp way with their political enemies. The only other point he would venture to mention was the peculiar connection and interchangeability between the terms political and moral in the Chinese system of thought. So far as he knew, the Chinese were above all a practical people, being in that respect a remarkable contrast to their Hindu neighbours, whose mode of thought was more metaphysical and contemplative. He would conclude by moving a hearty vote of thanks to Sir Thomas Wade, and by joining in the hope that at some future time he would further develop the subject.

The vote of thanks having been carried unanimously,

Sir THOMAS WADE, in reply, said he should like to make one remark on the observation of Professor Douglas, as to the facility with which the Chinese accepted a new ruler. He could hardly admit that Chinese history had proceeded quite so tranquilly as seemed to be supposed. There had been no change of dynasty without a fearful amount of bloodshed. What he thought was the secret of the continuity of Chinese dominion was that the new comers had not introduced new ideas. The Kin became civilized, although they were barbarians and embraced Confucianism, and the Mongols did precisely the same thing. The Manchus had prepared themselves for the conquest of China by a long study of Chinese literature, and changed hardly anything. Great changes might be in store for China, if she were conquered by a Western power. The grand source of the country's stability was the homogeneity of education, and the central principle

of that education, which was obedience; especially if to-morrow a foreign power or a number of foreign powers were to acquire China, they would immediately force upon the country a Christian civilisation, which they were bound to believe would be a great advantage, but which would be the utter destruction of the existing constitution. Whenever China was so weak as to become the spoil of one or more foreign powers, from that day she would cease to be China, and would become merely a territory subject to this power, or that, without a vestige of her former independence. The people were eminently governable; but the discipline which formed the grand secret of their governability was the obedience inculcated by the Confucian system, and by their family discipline.

Professor DOUGLAS said he quite agreed to with what Sir Thomas Wade had said. What he meant to insist upon was, that the extraordinary power possessed by the Chinese of absorbing any foreign elements, had enabled them to show such a remarkable continuity in their history.

NINETEENTH ORDINARY MEETING.

Wednesday, April 29, 1891; Professor SILVANUS THOMPSON, D. Sc., in the chair.

The following candidates were proposed for election as members of the Society:—

Cowburn, William Henry, 70, Market-street, Manchester.
 Fauvel, Charles James, 12, George street, Mansion-house, E.C., and 31, Camberwell-green, S.E.
 Miranda, Señor Don Francis de, Tumbes, Peru, and 16, St. George's-terrace, Gloucester-road, S.W.
 Richards, Thomas Robert, 25, Bedford-row, W.C.
 Salter, Stephen, jun., Pondwell, near Ryde, Isle of Wight.

The following candidates were balloted for, and duly elected members of the Society:—

Dowsing, Herbert John, The Cedars, Manor-park, Essex.
 Gostling, David, 1, Dalal-street, Fort, Bombay.
 Greey, Commander Robert, Eastern Telegraph Company's Cable Ship "Amber," Malta.
 Klein, Rev. Leopold Edmund Baynard, D.Sc., 11, Horbury-crescent, Notting-hill-gate, W.
 Moloney, His Excellency Captain Sir Cornelius Alfred, K.C.M.G., Lamarsh-house, Richmond-hill, Surrey.
 Tweedale, John, 12, South-parade, Leeds.

The paper read was—

THE USES OF PETROLEUM IN PRIME MOTORS.

BY PROFESSOR WILLIAM ROBINSON, M.E.

Petroleum, in the widest sense of the term, comprises not only the mineral oils found in the earth's crust, but also the oils obtained by the destructive distillation of coal and bituminous shale. These complex liquid hydrocarbons vary in appearance from that of clear light kerosene oils to heavy dark-greenish slush or semi-fluid slime. After the volatile or lighter oils have been driven off crude petroleum, the heavy oil left in the still is known as *residuum* in America, and in Russia it is called *astatki*. This *astatki*, or heavy petroleum refuse, is an excellent liquid fuel and is at least twice as good as ordinary coal for steam raising purposes.

The light lubricating oils, intermediate oils, and kerosene or ordinary lamp oils are all being used at the present time, instead of coal-gas in the cylinder of the internal-combustion engine. In some cases the heavier oils are converted into oil-gas, which, when cooled, is admirably adapted to drive gas-engines. Other internal-combustion engines, as, for instance, the Priestman, Akroyd and Knight, use common burning oils directly, and act as their own gas generators.

I am strongly of opinion that such dangerous and highly volatile hydrocarbons as benzoline, gasoline, and petroleum spirit ought not on any account to be used as fuel in gas-engines. The long series of accidents so frequently attending the use of these light volatile inflammable vapours, have done more than any other one thing to retard the development of this class of prime motor, by prejudicing the public mind against the appearance of oil in any shape or form. This highly volatile spirit may, however, act with safety as evaporating agent instead of steam, as in the Yarrow spirit launches, where it is used in the internal parts, and due provision made against leakage, whilst ordinary burning oil generates the heat.

It will thus be seen that liquid hydrocarbons, such as common petroleum oil, may be employed in prime motors as a substitute for either coal, or steam, or both.

Now, the properties and behaviour of steam in the engine cylinder have been very fully investigated. We have also a fairly exact idea of what takes place when a mixture of ordinary coal-gas and air is burned in the

cylinder of the internal combustion engine. So I have been led, notwithstanding the difficulties presented by the complex and varied character of the different burning oils, intermediate oils, and heavier lubricating oils at present in the market, to examine the relation between the pressure and temperature of their vapours, in order, if possible, to throw some light on their action in the cylinder of the common oil engine. At the same time, I have tried to find out which oils are best adapted for such use, by comparing their composition as regards the proportion of their more volatile constituents, with the results obtained when burning them inside the engine cylinder.

Messrs. Priestman Brothers have very kindly assisted me in this matter, and I take this opportunity to thank them for their valuable co-operation. They furnished me with samples of several kinds of oil used in their smallest engine, along with indicator diagrams, and figures obtained during special tests, made at my request, with a view to compare the performances of these different oils in the same cylinder. Some of the results obtained in these trial runs I have the honour to bring before this Society to-night.

I am also much indebted to Mr. Boverton Redwood, who kindly supplied me with several representative samples of American and Russian kerosene; of Scotch shale-oils from Mr. Love, of the Broxburn Oil Company; and of coal-tar oils—re-distilled "green oil" and "sharp oil"—from Mr. W. G. Blagden.

Table I. (p. 493) shows the specific gravity, flashing point, and colour, and may convey a vague notion of the odour of the typical samples I have collected and examined.

The specific gravity was determined by Derham's improved form of the Sikes hydrometer.

The flashing point (close test) was found by means of the standard tester devised by Sir Frederick Abel. The flashing point is the temperature at which the oil begins to give off an appreciable quantity of inflammable vapour, whilst slowly heated in a closed vessel. This is a very good test of the safety of an oil, as regards storage and use. In this country the lowest flashing point allowed for petroleum is 73° F. or 22·8° C. Most of the selected samples are well above the safe limit. A lighted match dropped into any of these oils is extinguished; even a burning taper is put out when held in the most volatile of them. Indeed, the electric arc may be made to pass between two carbon rods immersed in the oil

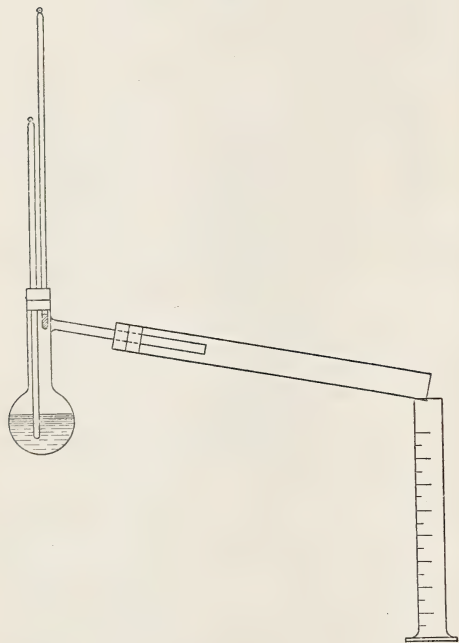
TABLE I.—TYPICAL SAMPLES OF OIL.

Mark.	Name of sample.	Sp. Gr. at 60° F.	Flashing point by Abel close test.		Colour.	Odour when cold.	Boiling point by Thern. A In liquid.	First drop distilled at temperatures.		Distillation under vacuum.		Volume distilled.	Time.
			P.	C.				A Liquid.	B Vapour.	A Liquid.	B Vapour.		
	<i>Kerosene.</i>		deg.	deg.			deg. C.	deg. C.	deg. C.	deg. C.	deg. C.	per cent.	hrs.
R I.	American Water-white .....	.780	108	42	Clear, colourless ..	Pleasant	145	175	110	215	200	56	3
R II.	" Ordinary .....	.791	75	24	" very pale straw	" more singed	145	154	95	223	200	36	"
P I.	" Royal daylight ....	.799	76	24.5	" " "	" slightly pungent	144	157	100	230	198	34.5	"
P II.	" Tea rose .....	.797	83	28.3	" slightly turbid	" " "	150	167	107	243	202	37	"
R III.	Russian ordinary .....	.825	82	27.8	" with fluorescence	" " "	151	166	105	221	200	35.5	"
P III.	Broxburn Light-house .....	.811	152	66.7	Very clear	Scarcely any odour.	162	211	120	243	230	56	3
R VIII.	" " .....	.811	152	66.7	Straw colour	" " "	170	214	140	274	270	90	1½
P IV.	Trinity House .....	.811	152	66.7	Very clear	" " "	164	211	135	243	230	54	2½
R VII.	Broxburn Petrolene .....	.805	96	35.6	" " "	Pungent odour....	160	177	120	265	242	65	2
	<i>Intermediate Oils.</i>												
R IV.	American Mineral sperm ....	.833	..	..	Clear straw	Strong burnt odour	195	285	115	290	230	4.5	3
R V.	Storror's Scotch Gas oil .....	.843	..	..	Reddish brown, no fluorescence	Strong singed odour	195	274	156	280	230	5	"
M	Scotch Intermediate shale oil..	.846	..	..	Clear brown, with fluorescence	Slight heavy odour, not pungent	195	252	142	291	261	18	2
A	Light Lubricating oil .....	.854	..	..	" " "	More singed	195	255	125	285	266	17	2
	<i>Coal-tar Oils.</i>												
R V.	Sharp oil	1.062	153	67	Opaque dark green, tarry, with sediment	Strong, unpleasant tarry smell							
R VI.	Green oil (re-distilled)	1.110	208	98	Greenish brown ..	Disagreeable, heavy smell of gas lime							

without igniting it, but the oils soon become charred. A small piece of red-hot iron is made quite cool when thrown into any of these oils, although the frequent repetition of this experiment on a sample of oil is not attended with agreeable odours. In the case of heavy liquid fuel, "astatki" (flashing point 212° F), this experiment may be repeated with perfect safety, and such "residuum" may be carried and used on board a man-of-war with less danger than there is with coal.

The proportion of the more volatile constituents in the typical samples was found by fractional distillation. The same measured volume of oil taken in every case was equal to that of 1,000 grains of pure water at 60° F. This was heated in a glass flask

FIG. 1.



(Fig. 1) by the flame of a Bunsen burner, shielded from draughts. The burner and sandbath are not shown in the diagram. One thermometer, A, was kept immersed in the oil, the other, B, gave the temperature of the vapour at the neck of the flask opposite the exit-tube leading to the condenser. The distillate, as it condensed, trickled from the glass tube and was allowed to drop into the graduated vessel. The temperature of the liquid was noted when boiling commenced vigorously, and the indications of both thermo-

meters observed when the first drop distilled over. The distillation took place in steps or stages, and it was found necessary to increase the heat by making the flame slightly larger when distillation ceased at any one temperature. Sometimes the rise in temperature took place rapidly from one stage to the next; at others, the changes were slow and gradual. I have endeavoured to represent this (Fig. 2) by the steepness of the curves, for these steps, joining the points in each step. The difference between the indications on the two thermometers, due to the cooling and condensation of the vapour on the bulb of B, depend on the size and shape of the flask, and the heating flame. This difference becomes less and less as the temperature increases.

Four sets of readings (Table II.) will serve to interpret the curves (Fig. 2, p. 497).

A glance at the curve for American "Water-white" shows that this oil distils over within a limited range of temperature, when compared with that for other samples of kerosene. The explanation is obvious. Any substance of simple constitution, pure water say, would nearly all be distilled over at the same temperature, 100° C., provided the pressure remained the same throughout. Such a process would be represented by a vertical straight line. "Water-white" oil approaches more closely to this than the other oils; and Mr. Boverton Redwood has pointed out that, at the refineries, the first and last portions which distil over—technically known as the "tops and bottoms"—are rejected from "Water-white," so that this oil contains fewer hydrocarbons, and is, consequently, of more uniform composition and simpler constitution than the usual run of ordinary kerosene oils. The same remark applies to the Lighthouse oil. Obviously, the oils marked "Trinity House" and "Lighthouse" are one and the same. They agree in specific gravity, flashing-point, and appearance. Moreover, the fractional distillation proves them to be made up of hydrocarbons having the same boiling point. This conclusion is abundantly proved by further examination. The R VIII. sample of this oil is of a straw colour; the others are quite clear; and all fulfil the Trinity House conditions. Their specific gravity is above .810; flashing-point is well above 125° F., being 152° F.; and they would evidently distil between 150° C. and 300° C. Since, in one case, 90 per cent. distilled under 270° C., we did not venture to

TABLE II.—FRACTIONAL DISTILLATION.

Sample R I.

AMERICAN "WATER-WHITE."

A Temperature of Liquid.	B Temperature of Vapour opposite exit-tube.	Remarks.	Per-centage distilled at each temperature.
Deg. C.	Deg. C.		
100	..	Gas evolved.	..
120—140	..	„ „ rapidly.	..
140—150	..	Boiled.	..
162—172	..	„ vigorously.	..
175	110	First drop distilled.	..
176	145	Distilled regularly.	..
180	148	A constant, distillation stopped, B fell to 130° on increasing flame.	..
181	151	A slow, B rapid rise	3
183	161	„ „ to 161°, then constant.....	5
186	165	„	3
188	171	„ „ B faster	4
191	174	Fairly slow	4
193	176	„ „	3
196	179	„ „	5
197	181	„ „	3·5
200	183	.....	4·5
202	186	Distillation stopped, so increased heat	2·5
208	188	A fairly rapid, B slow	6·5
210	188	B constant	5
211	197	Distillation stopped, flame raised	5
215	200	Slow distillation.....	2
		Time, about three hours.	50

R VIII.

BROXBURN LIGHTHOUSE OIL.

Time (minutes).	A Temperature of Liquid.	B Temperature of Vapour oppo- site exit tube.	Remarks.	Per-centage distilled at each temperature.
	Deg. C.	Deg. C.		
..	110	..	Gas evolved.	..
12	170	..	Boiled.	..
..	200	..	„ vigorously.	..
20	214	140	First drop distilled, A slow, B rapid	1·5
5	216	190	„ „ „ „	
10	219	196	{ A slow, B fast to 196°, and then constant, urged flame when temperature falling	4
18	223	205	A slow, B fast to 205°, and then constant	6
15	226	211	A slow, B fast to 211°, „ „	6·5
6	232	224	„ „ 221°, and slow	17
10	240	232	Both slowly rising	15
7	249	242	„ „ „	11
5	255	250	„ „ „	10
7	264	260	„ „ „	10
6	274	270	„ „ „	9
101			Time, 1 hour, 41 minutes.	90

Sample P III.

LIGHTHOUSE OIL.

A Temperature of Liquid.	B Temperature of Vapour opposite exit tubes.	Remarks.	Per-centage distilled at each temperature.
Deg. C.	Deg. C.		
128—130	..	Gas bubbles evolved very slowly.	..
136—138	..	" " " very rapidly.	..
160—162	..	Boiled.	..
190—192	..	" vigorously.	..
209	..	A constant for few minutes, B rising.	..
211	120	First drop distilled.	..
211—214	120—195	A nearly constant, B rose rapidly	4.5
214—218	195—202	" temperature slow, distilled fast	4.5
218—222	202—208	" " " " "	7
222—225	208—213	" " " " "	5
225—227	213—216	" " " " slowly	4
228—230	217—218	A constant, B falling, so increased flame	7
233—235	221—223	Temperature constant, distilled fast	10
235—237	223	{ A slowly rising, B constant, falling	3
		{ increased flame, distilled slowly	
237—240	223—225	Very slowly, distilled moderately	5
243	226—230	" " and constant	6
		Time, about three hours.	56

P IV.

TRINITY HOUSE OIL.

A Temperature of Liquid.	B Temperature of Vapour opposite exit tubes.	Remarks.	Per-centage distilled at each temperature.
Deg. C.	Deg. C.		
125—127	..	Gas evolved slowly.	..
143	..	" " rapidly.	..
164—166	..	Boiled.	..
193—195	..	" vigorously.	..
211	135	First drop distilled.	..
211—216	135—195	A constant, B rising rapidly	4.5
216—219	192—202	" " " distilled fast	4
219—221	202—205	A rising slowly	2
221—225	205—209	" " distilled fast	10
226—229	209	A glow, B constant, distilled moderately	5.5
229—232	209—211	" " " "	5.5
232—234	211	" " " "	2.5
234—236	211—214	{ " B varying, falling	5
		{ increase flame	
236—239	214—221	" B fast to 221° and constant	4.5
241	221	{ A rising, B constant, distilled moderately	3.5
		{ increased flame, and B rose rather rapidly ..	
243	228—230	Distilled fast	7
		Time, about 2 hours 30 minutes.	54

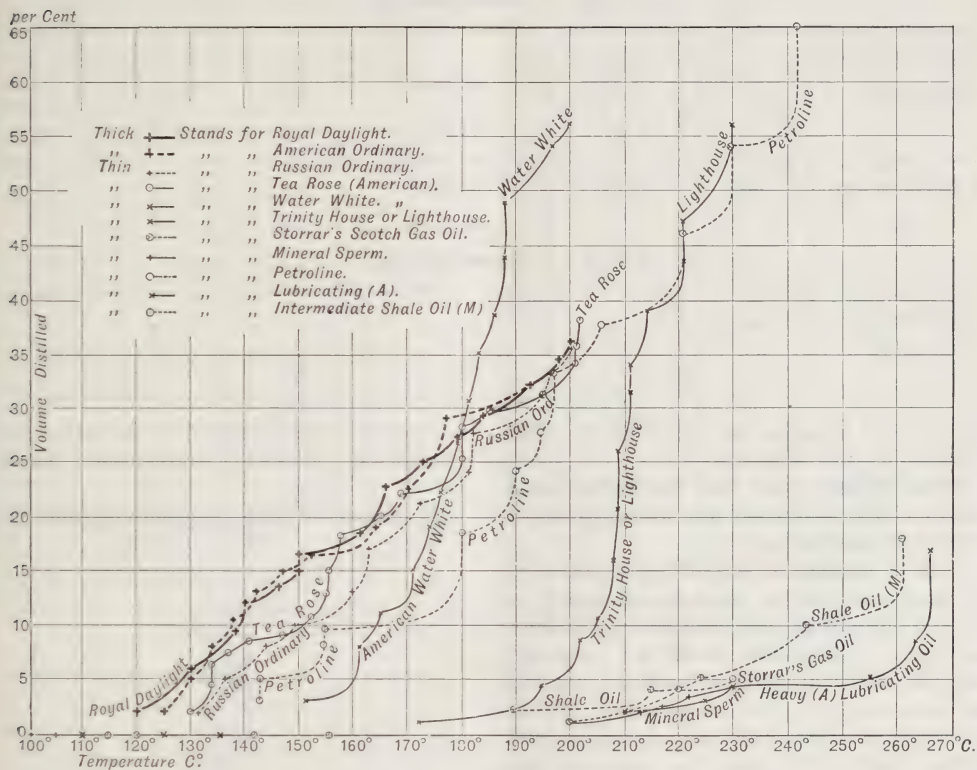
push the evaporation further, for fear of breaking the flask.

The other kerosene oils contain hydrocarbons, driven off almost continuously above the boiling point. Still, each sample has its marked characteristic, shown by the stages at which its various constituents come off and distil over.

Thus "Royal Daylight," the ordinary lamp oil supplied by the Anglo-American Oil Com-

pany, distils off gradually through a very wide range of temperature. It boils at 140°C . and begins to distil about 160°C . (liquid), at 236°C . only 35 per cent. is distilled, at 300°C . only 76 per cent., at 340°C . 82 per cent., and the amount fell off when the thermometer reading reached the limit of 358°C . Several other samples of this brand gave similar results up to 230°C ., only one being urged to the extreme temperature indicated. The amount

FIG. 2.



FRACTIONAL DISTILLATION CURVES.

that distils at any one temperature varies slightly with the rate of heating.

The intermediate oils, as seen by the curves (Fig. 2), yield only small per-centages of distillate, within the observed limits of temperature.

It was proposed to try another method of testing whether these oils contain appreciable quantities of volatile constituents.

EVAPORATION.

We found the loss of weight in the heavy oils by prolonged heating at low temperatures, whilst the oils are exposed to the air and allowed to evaporate freely. A known weight of oil was taken in shallow platinum and nickel

dishes, each about three inches across the top, and gently heated on a sand-bath by the very small steady flame of a Bunsen burner, supplied by coal gas at constant pressure. Evaporation was encouraged in this way for an hour and a half, the temperature of the oil being kept constant. The flame was removed, and the oil weighed after it had cooled on the sand-bath.

Green oil and lubricating oil were also evaporated on a steam-bath during three hours and when cold the loss in weight was noted.

The coal tar oils do not appear to have any effect on litmus paper, pointing to the absence of ammoniacal vapours.

The proportion of volatile constituents pre-

TABLE III.—OIL EVAPORATION.

Name of Sample.	Specific Gravity at 60° F. (15·5° C.)	Weight taken. (Grammes.)	Constant Temperature. (Centigrade.)	Time of Evaporation. (Hours.)	Per-centage Loss.	Total Per-centage Loss in Three Hours.
			Degrees.			Per Cent.
Green Oil	1·110	41·7650	40 to 45	1·5	0·61	2·46
	..	..	65 to 75	1·5	1·85	
	..	59·6738	Steam Bath (95)	3	4·45	4·45
Intermediate } Shale Oil .. }	·846	42·4223	40 to 45	1·5	1·12	3·57
	..	..	65 to 75	1·5	2·45	
Lubricating Oil.. (A.)	·854	42·2200	40 to 45	1·5	1·00	2·96
	..	..	60 to 65	1·5	1·96	
	..	22·6003	Steam Bath (95)	3	12·42	12·42
Broxburn Light- house Oil .. }	·811	43·8363	40 to 45	1·5	1·63	6·95
	..	..	60 to 65	1·5	5·27	

sent in the samples, as indicated by their evaporation, are tabulated:—

These figures show that ventilation of oil tanks is desirable, at any rate when exposed to tropical temperatures.

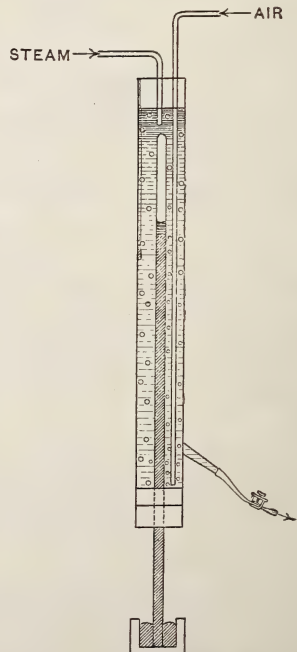
Captain Carmichael states* that in Peru the oil residuum used as fuel does not appear to give off any gas, and is stored in large tanks—one holds 37,000 barrels of oil—left open and exposed to the air without suffering any deterioration or perceptible evaporation. Owing to the Arctic current, the temperature is never higher than 78° F. along the coast of Peru. Such a climate is well adapted for oil, of which there is an abundant supply. Important oil centres are now being opened up on the West Coast of South America, where oil can be put into ships alongside the wells at £1 per ton, and the steamships of the Chilian Company use upwards of 100,000 tons a year.

PRESSURE OF PETROLEUM VAPOUR.

With this definite information as to the volatile nature of these samples of oil, the next series of experiments were undertaken

to determine the pressure* of the petroleum vapours at different temperatures below 100° C.

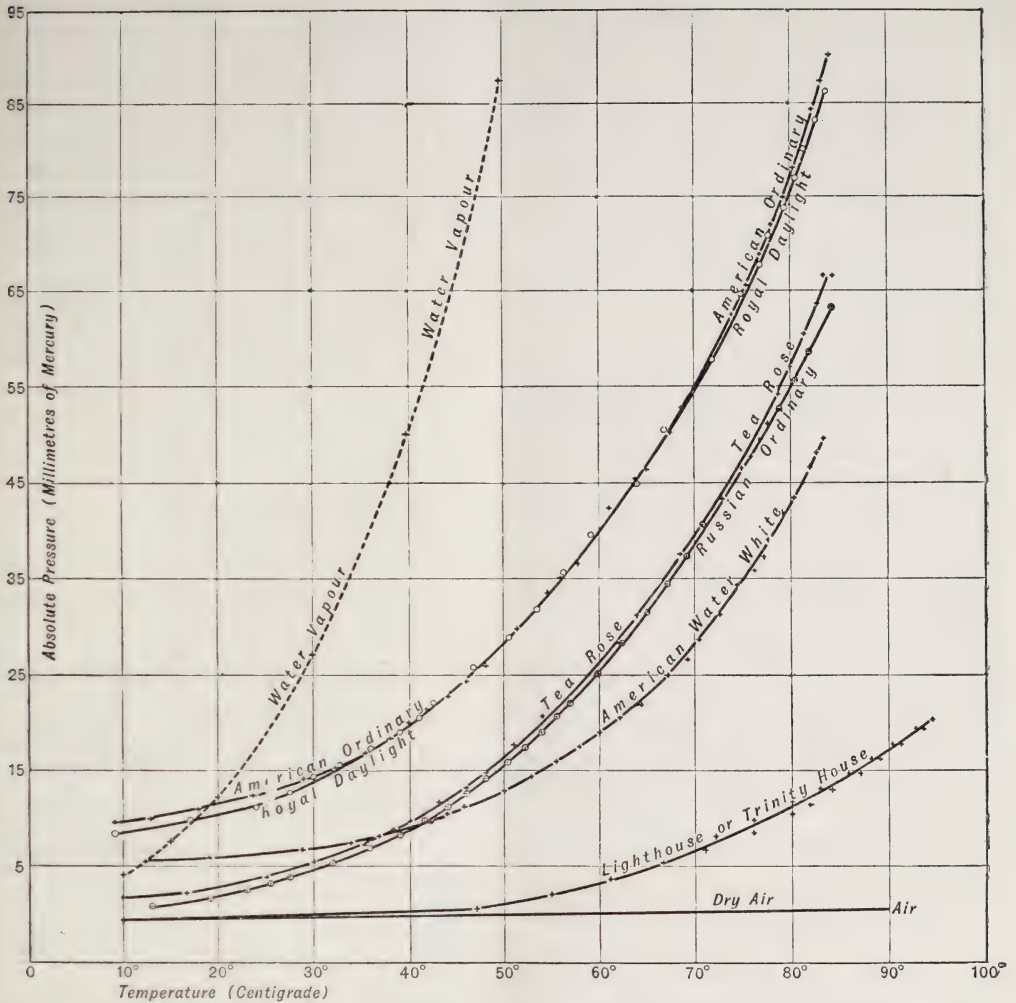
The apparatus (Fig. 3) used to measure the



* See paper on "Liquid Fuel in Ocean Steamers," before the Shipmasters' Society of London, Feb. 13, and published in the *Shipping Gazette* and *Lloyd's List*, of Feb. 19, 1891.

* I am aware that, in the petroleum tester of Salleron and Urbain, the vapour pressure is observed, and the flashing

FIG. 4.—PRESSURE AND TEMPERATURE OF PETROLEUM VAPOURS.



pressure of petroleum vapours below 100° C., simply consists of a barometer tube, thoroughly dried inside, and filled with clean mercury. About two cubic centimetres of oil is introduced above the mercury into the Torricellian vacuum at the top of the tube, which stands in a long, deep trough of mercury. The water-bath surrounding the upper part of the tube is gradually heated by steam passed into it, whilst a current of air is forced into the bottom of the bath and allowed to bubble up, thus causing a continuous circulation, and maintaining the temperature of the bath fairly uniform throughout.

Before heating the water, its temperature

point deduced therefrom; but the relation between these is not found to be sufficiently definite, exact, or satisfactory even in ordinary rough approximations for commercial purposes.

and that of the room is noted, as well as the heights of the mercury in the tube and in the standard barometer close by. The water bath was heated very gradually, and the difference of level between the surface of the mercury in trough and tube was observed at the same time as the temperatures. Numerous heating and cooling readings were taken with each sample of oil, and, as a check on the best rate of heating, the bath was frequently kept at the same temperature for two or three minutes, to see whether the oil had at first attained its full pressure corresponding to the temperature indicated by the thermometer in the bath.

The observed heights of the mercury in the standard barometer, and in the tube containing the petroleum vapour, were reduced to what they would be at 0° C., the parts of the tube

in and out of the bath being taken separately. The pressure of the mercury vapour in the tube was neglected, besides it would be practically the same in every case.

The difference between the corrected heights of mercury in the tube and standard barometer was taken as a measure of the pressure with which the petroleum vapour pushed down the mercury column. These corrected pressures were plotted with the corresponding temperatures on squared paper, and give the curves (Fig. 4, p. 499).

That of water vapour is shown merely for the sake of comparison.

The regularity of these curves is striking.

Within this range of temperature "Royal Daylight" and "American Ordinary" practically agree, and give higher pressures than any of the other samples of kerosene. It would appear from these curves, considered along with those from the fractional distillation, that the more volatile constituents in these two samples of oil are the same—that is to say, the "tops" are the same in both. "Tea Rose" closely agrees with the "Russian Ordinary," but contains a larger proportion of the light products. On the other hand "Water-white" is quite distinct in its character from the other samples of kerosene, and comes nearer that of the "Lighthouse Oils," which, however, give very much lower pressures, only $\frac{1}{250}$ th of an atmosphere when heated up to 95° C. in a vacuum.

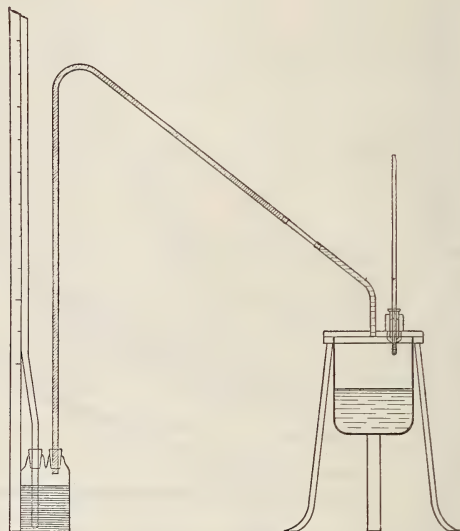
The pressure of water vapour is much higher than any of these oils give.

MEASUREMENT OF THE PRESSURE OF PETROLEUM VAPOURS AT TEMPERATURES ABOVE 100° C.

In proceeding to investigate the pressure of oil vapours at temperatures above 100° C., we met with some difficulty, owing to the leakage at joints. This vapour oozed through ordinary leather washers which had been soaked in oil before being screwed tightly into the joints, and the leather was reduced to a brittle cinder. Asbestos and red lead were tried in vain, but at last it was found that fine linseed meal, mixed with boiling water, made an effective poultice for the joints, and when dry succeeded, with good metal fittings, in stopping the petroleum vapour for a time. These preliminary tests were made with a Marcet's boiler, such as I had frequently used to test the pressure of steam at temperatures above 100° C. This apparatus came to grief in the hands of the brazier. Afterwards a Papin's digester was

fitted, as in Fig. 5, with a mercurial pressure gauge. The boiler is of copper, with three holes in the lid. One was ground to fit tightly a conical plug, supposed to act as a loaded safety valve; another served for the thermometer, with spaces turned out for packing; and into the third was soldered a brass tube. A piece of lead pipe sloping upwards for a length of about two feet at first, connects the boiler to the mercurial pressure-gauge. This simply consists of a strong glass bottle with tight-fitting corks, tied down and covered over to make them perfectly gas tight. The gauge tube was fixed to a wooden upright carrying a graduated scale. During all the experiments the lead tube re-

FIG. 5.



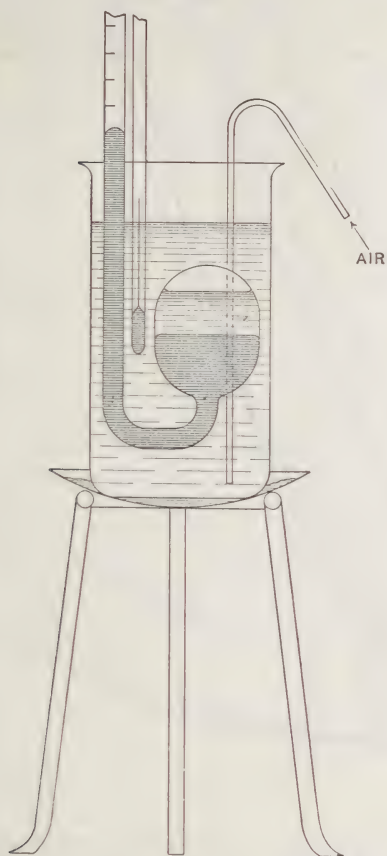
maintained quite cool, even when the vapour in the boiler was above 195° C. Any traces of vapour that passed into the brass tube were condensed, and dropping back into the boiler, made a frying or roasting noise, accompanied by a momentary but rapid rise in both the temperature and pressure.

The boiler would hold over a pint, but less than the half-full of it was taken. All the joints were soldered, except that at the thermometer, which invariably gave way, and caused leakage, which, although imperceptible, was accompanied with fall of pressure and temperature. In some cases this was only detected by the curves from the reduced readings. In all, about three weeks was spent with this apparatus, without any reliable results.

The last and simplest arrangement adopted consists of a piece of graduated glass tube,

bent into U-shape, with a bulb blown on the end, as shown in Fig. 6. The graduated tube is about a yard long, and 5 millimetres bore. The bulb is elongated egg-shaped, of 30 cubic centimetres capacity, average diameter 30 millimetres, and length 40 millimetres. Having thoroughly cleaned and dried the bulb, it was filled with mercury, and 7 cubic centimetres of the oil was introduced in every case, occupying about one-fourth of the bulb. The quantity

FIG. 6.



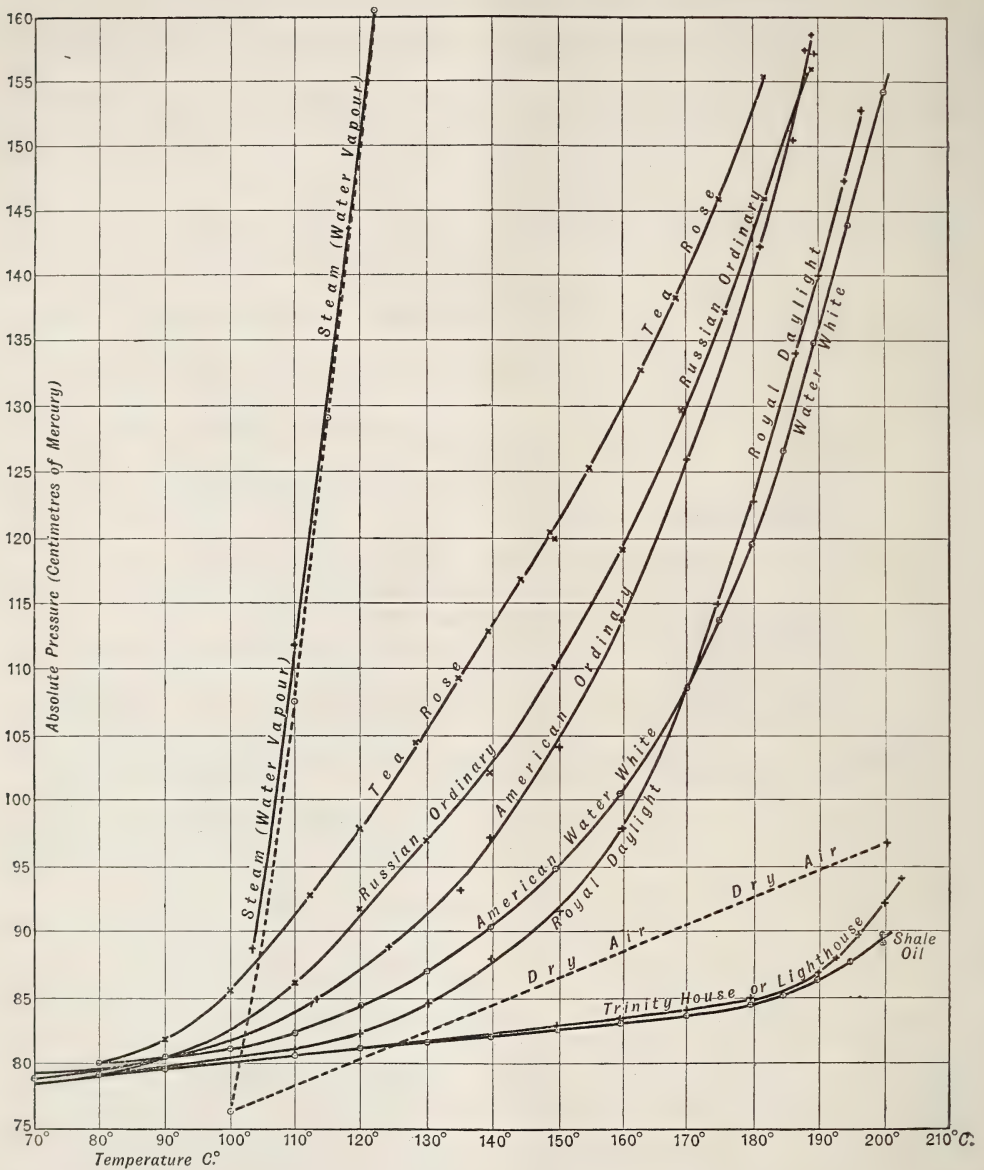
of mercury was adjusted to stand at the same level in the bulb and tube when put into the bath of glycerine. The height of the standard barometer was observed, and the temperature of the room and bath noted. This bath was gradually heated by a Bunsen burner, and stirred with a current of air, which kept the whole mass of glycerine at a uniform temperature. As the temperature of the glass rose, the glass bulb and tube were first heated and expanded; after a certain interval of time, the mercury and oil took up the same temperature, and expanded accordingly. Thus, the

apparent rise of mercury in the tube was the net result of the expansion of the oil and mercury diminished by the expansion of the glass. This was found to be 0.5 millimetre for every 1° C. rise in temperature. The co-efficient of expansion of mercury is 0.00018, and that of petroleum varies from 0.0007 to 0.0006 for 1° C. Allowance could thus be made for the rise of the mercury due to liquid expansion, apart from vapour pressure. As the bath was gradually heated, the difference of level of the mercury in the tube and bulb was observed, and the corresponding temperature of the bath. Before taking a reading, the bath was kept at the same temperature for some time, and readings were taken every 5° C. Taking the mean temperature of the mercury, the observed height was reduced to what it would be at 0° C. The next difficulty was to correct for the rise of mercury in tube, due to the change in volume of the oil in passing from the liquid to vapour. On this account the rise of mercury was noted, and many readings taken in each case long before a single bubble of oil-vapour was formed. The greatest change in level of the mercury in the bulb was due to the increased volume of oil and vapour, and varied from 16 to 18 millimetres, corresponding to a change of level of mercury in the tube of 840 millimetres. The range was mostly limited by the length of our graduated tube, but we did not care to push the glycerine much above 200° C.

In order to verify our work, we tried water, and obtained the curve shown in Fig. 7 (p. 502), which, above 100° C., practically coincides with that obtained by plotting Regnault's figures. Thus encouraged, and, by numerous experiments, in taking oft-repeated heating and cooling readings for every sample of the kerosene and some heavy oils, we obtained the results which, when reduced and corrected, as indicated above, and plotted on squared paper, give the curves in Fig. 7. These are at least comparative results, the same quantity of every oil being used, and subjected to the same conditions.

The law according to which the pressure of petroleum vapour varies with temperature is thus represented by a perfectly regular curve for each oil. Moreover, the relative steepness of these curves is somewhat similar to that obtained by fractional distillation curves of these oils. The petroleum vapour pressure is seen to be less than that of steam, but gradually approaching it as the oils become

FIG. 7.—PRESSURE AND TEMPERATURE OF PETROLEUM VAPOURS.



more volatile, until, in the case of the petroleum spirit used by Mr. Yarrow, the pressure (Fig. 8, p. 503) exceeds that of steam.

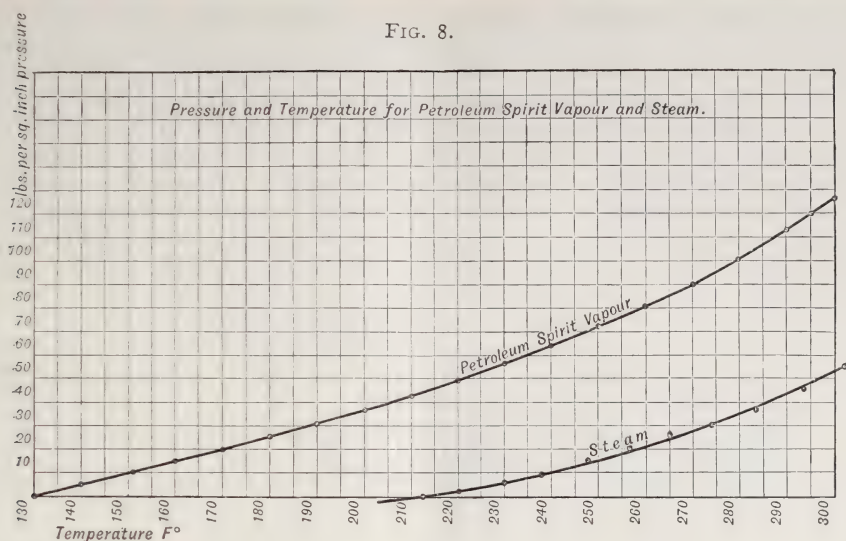
The full meaning of these curves will be more easily grasped after we have considered the action in the common petroleum engine.

I must here take this opportunity to express my hearty thanks to my colleague, Professor Frank Clowes, D. SC., and his assistants Messrs. Coleman and Rigby, for many valuable suggestions, whilst Mr. T. H. Adams, senior scholar in the chemical department of University

College, Nottingham, took for me many of the numerous and tedious sets of readings represented by the curves. Some of my second year engineering students, notably Messrs. Medley, Hamlyn and Addyman, also gave me zealous help in preparing many of the large diagrams you see on the walls to-night.

The first use of petroleum in prime motors is as a substitute for gas in the internal combustion engine. Here the heat, generated by the combustion of a mixture of oil vapour and air inside the engine cylinder, is used directly

FIG. 8.



to expand the products of combustion, and so drive forward the piston.

PRIESTMAN OIL-ENGINE.

Just as the Otto gas-engine, in the hands of Messrs. Crossley Bros., in this country, has been developed into a reliable and useful prime motor, inspiring public confidence, which had been shaken by the Lenoir failure, so to Messrs. Priestman Bros. is due the credit of the further development of the gas-engine into the common oil-engine which has now established itself as a still more useful and popular prime motor, since its fuel—ordinary burning

oil—is to be had in every country village, and the engine itself can be looked after by unskilled hands.

Its record has been so satisfactory, that it even excels the parent gas-engine in replacing small steam-engines, and it is to be found doing good work efficiently at the colliery, mine, and lighthouse station.

The action in this engine can be readily explained by means of the wall-diagram. The oil supply requisite for a run of a day or two is contained in a reservoir, or closed iron vessel, placed inside the casting forming the foundation of the engine. In case of a pro-

FIG. 9.—PRIESTMAN'S OIL SUPPLY BY GRAVITATION.



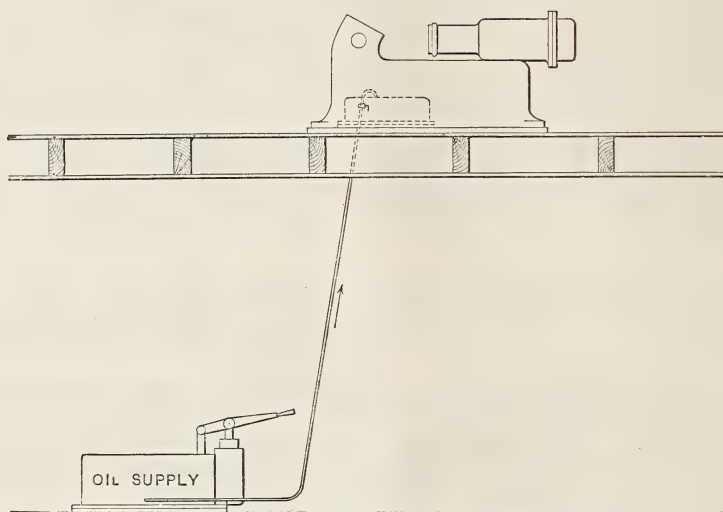
longed run, this reservoir may be replenished from the large oil tank by gravitation as in Fig. 9, without ever stopping the engine. The air-pipe connecting the two vessels allows the pressure to become the same in both, and the oil flows down by reason of the "head," or difference of levels. In places where this is inconvenient, a hand-pump (Fig. 10, p. 504) may be used to force the oil up into the reservoir.

Probably the most ingenious and characteristic part of this engine is the *vaporiser*, or device for breaking up the oil, and mixing the incoming air with it. The air pump, worked from the main shaft, forces oil into the reservoir, and sends a stream of oil and of compressed air along separate tubes to the spray maker. The oil injected through this inverted nozzle is thoroughly broken up, and intimately

mixed with the incoming air playing upon it. This mixture of fine spray and air is heated, and completely vaporised by the hot products of combustion led round this vaporising chamber, before being allowed to escape by the exhaust. This vapour, thus thoroughly mixed with air, is drawn through an automatic suction valve into the engine cylinder by the piston in its forward stroke.

The effect of this *spray-maker* will be seen by the actual working of the complete little plant which, through the kindness of Messrs. Priestman Bros., I have on the table. There is a cock here in the air tube (which is not, of course, placed in the air tube of the engine), so that, by turning off the air, I can clearly demonstrate the fact that a flame of gas has no effect upon the oil jet in

FIG. 10.



PRIESTMAN'S OIL SUPPLY BY PUMP.

its unbroken condition. Now, I allow the air to break up and completely spray the oil, becoming so intimately mixed with it, that the mixture can be ignited, and burns without further heating. (Experiment shown.)

This mode of breaking up the oil prevents any large deposit in the vaporising chamber, which, under ordinary care, does not require cleaning oftener than once in 9 or 12 months. The proportion of the mixture allowed into the vaporising chamber, as well as the quantity of cold air to mix with it, are controlled by a governor driven directly from the crank shaft. The mode of governing consists in reducing the strength of the charge admitted into the cylinder. There always being a proper mixture of gas and air, the engine never misses an explosion. (This was shown by a set of cards.)

The cycle of operations in this engine cylinder is that of Beau de Rochas, the same as in the well known Otto gas-engine.

After the charge of oil vapour and air is drawn into the engine cylinder, it is compressed by the piston during the return stroke. Here a certain small fraction of the heavier

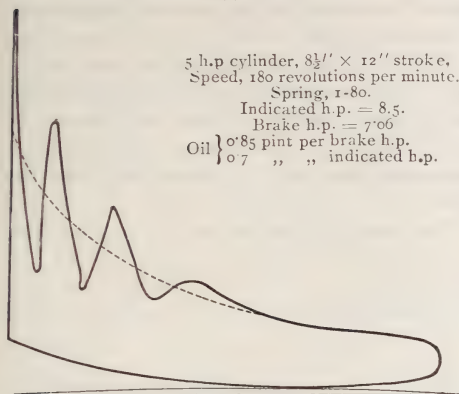
constituents of the oil undoubtedly are condensed on the cold part of the cylinder walls, and go to keep the cylinder moist and well lubricated, whilst a larger proportion is evaporated and burned during the explosion or working stroke. In the latest design the petroleum vapour is more thoroughly mixed with cold air, allowing a higher compression of the charge before firing, and thus obtaining a corresponding increase of power.

The compressed charge is fired at the proper moment by the side shaft closing the battery circuit of an induction coil, and thereby causing a spark to play between the points of two platinum wires insulated by porcelain in the igniting plug screwed into the end of the engine cylinder. I have examined this igniting plug (plug shown) and its porcelain insulators after a long day's run with ordinary lamp oil, and in every case they have been perfectly clean, without the slightest secretion of carbon.

The exhaust valve, a simple T-shaped mushroom, is held against its seating by spiral springs, and is opened inwards to the cylinder by a lever worked by the side-shaft. [The

burnt products escape around the vaporiser, so that their heat, which would otherwise be rejected and lost, is utilised in aiding the conversion of the incoming oil-spray into vapour. We have in this a most useful and important application of the regenerator.

FIG. 11.



PRIESTMAN'S OIL ENGINE DIAGRAM.

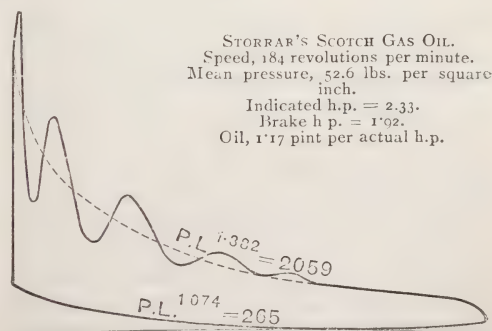
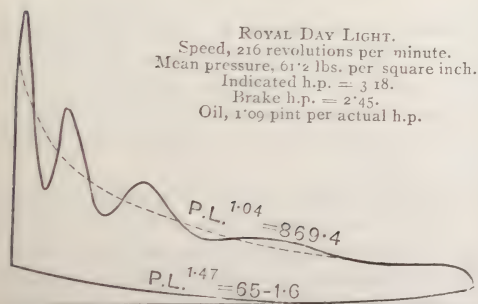
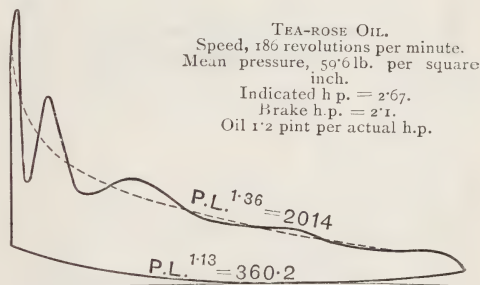
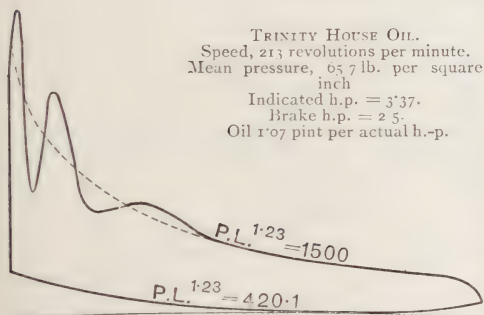
The indicator diagram, Fig. 11, from a nominal 5 horse-power engine, cylinder $8\frac{1}{2}$ inches diameter and 12-inch stroke, shows the compression before ignition 33 lb. per square inch, and the mean pressure throughout the stroke

54.4 lbs. The speed was 180 revolutions per minute, the air pressure 10 lb. per square inch, and the net weight on fly wheels 90 lb., giving 7.06 brake horse-power. The measured oil consumption comes out 0.85 pint of Royal Daylight per brake horse-power per hour. Taking the price of this oil delivered in bulk, as the American Oil Company are now doing, $5\frac{1}{4}$ d. a gallon, the cost of an actual brake horse-power by this small engine is less than a half-penny per hour. Large engines give still greater economy.

The set of indicator cards (Fig. 12) were taken, during the special test above referred to, on a small one-horse power engine, having diameter of cylinder $4\frac{1}{2}$ inches, and piston stroke 12 inches. The capacity of the compression space of the explosion chamber is 88 cubic inches, while the volume represented by one stroke of the piston is 191 cubic inches.

The proportion of air in each explosive mixture is 191 cubic inches with .015 of a cubic inch of oil. The approximate temperature of this working charge, as it passes into the cylinder, is above 170° F. The large admixture of air keeps nearly all the petroleum in a state of vapour even while being compressed, as the curves show to a very considerable extent.

FIG. 12.

DIAGRAMS FROM 1 H.P. CYLINDER $4\frac{1}{2}'' \times 12''$ STROKE.

The laws of these compression curves show slight condensation as compared with the compression in gas engines. This is obvious when we bear in mind how the pressure of petroleum vapour rises far more rapidly than air, whilst these compression curves do not rise nearly so rapidly as in some gas-engines. Of course the proportions of the cylinder and compression chamber also affect the degree of compression.

Remarkably good results are thus obtained with such a heavy oil as "Storror's Scotch Gas-Oil," part of which must have condensed, and then burned again during the expansion, when the temperature increased in the cylinder. Further, the "Trinity House Oil," thus mixed with a large proportion of air, being a more

homogenous oil than most other samples of kerosene (compare curves Fig. 2 and 12), gives the highest mean pressure, since its vapour is all formed rapidly within a limited range of temperature. There is thus high explosion pressure, whilst, at finish of the three hours trial run, the temperature of the jacket water from the working cylinder was comparatively low in every trial.

These curves indicate good combustion, and consequently it was to be expected that the igniting plug would show no traces whatever of deposit after each run, and careful examination abundantly proved this to be the case.

This small engine, in two runs of three hours

FIG. 13.
AKROYD OIL-ENGINE DIAGRAMS.
Cylinder, $9\frac{1}{4}'' \times 16''$ stroke.

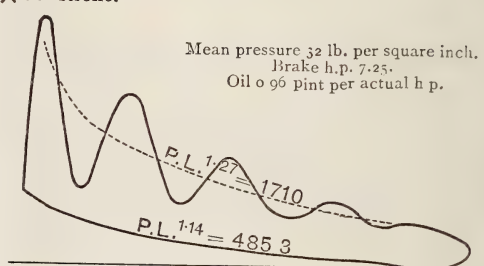
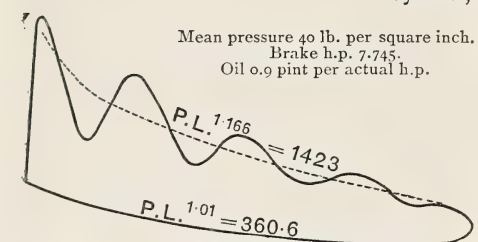
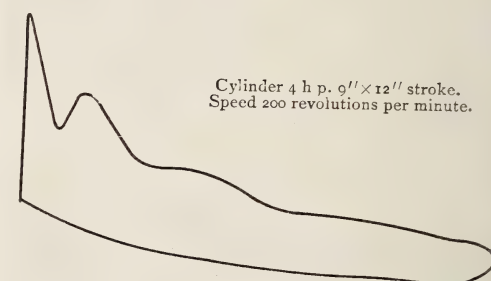
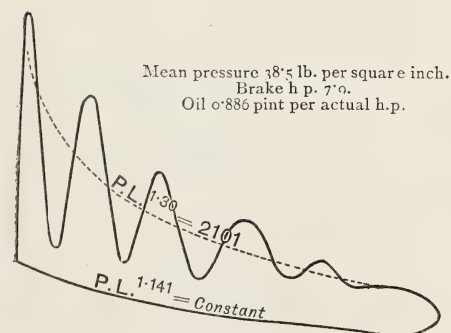


FIG. 13A.



Spring Scale, 1.64th; speed, 216 revolutions per minute.

each, gives an average of 2.5 actual horse-power developed from the Broxburn Lighthouse Oil without any undue heating, giving a consumption of 1.07 pints per actual horse-power per hour. Larger engines, as shown by the indicator, diagram Fig. 11, give still better results for electric lighting and all kinds of industrial work. In fact, this engine invariably receives an excellent character for its steady and trustworthy conduct, proving the best of its kind hitherto in the market. Mounted on wheels, it becomes useful for agricultural and many other purposes.

"AKROYD" OIL-ENGINE.

The next oil-engine I wish to bring under your notice is the invention of Mr. Herbert Akroyd Stuart, of Bletchley, formerly a junior assistant at the Finsbury Technical College, in the early days of the Mechanical Engineering Department.

The novel feature of this engine is that the ordinary arrangements for firing the charge by heated tube, flame or electric spark, which have been found so troublesome in the gas-engine, are dispensed with altogether, and much heavier oils can be used with advantage,

whilst the working parts are few and simple. A cartridge or combustion chamber, at the end of the cylinder, provided with webs giving a large heating surface, is heated up at start, and afterwards its temperature is adjusted where necessary by an air current allowed to pass round it by natural draught. This cartridge is kept red-hot inside, and the oil injected into compressed and heated air burns readily. A comparatively small opening leads to the compression chamber of the working cylinder.

The air and exhaust valve, of the T-shaped mushroom type, are seen side by side underneath the clearance space, so that some of the exhaust heat may go to warm up the incoming air.

The oil cistern is fitted in the base of the casting, exposed to ordinary atmospheric pressure, and the oil supply can easily be replenished at any time during a run, by sliding open the top cover and pouring in the oil. Every charge of oil is drawn from this cistern, and forced through a thin pipe and simple nozzle into the combustion chamber just at the proper moment for ignition—after the hot air has been compressed, and the piston is on the return stroke. The oil supply can be adjusted to suit the load, by means of a handle which varies the lift of the pump-plunger.

In the case of a 6 horse-power engine which I tested during a preliminary trial run of about three hours, the oil-pump plunger was $\frac{1}{2}$ -inch diameter, and less than 3.32-inch lift, giving about .015 cubic inch of oil for each charge. It would at first sight appear, as I thought, that, by working this pump out of its proper time, the pre-ignitions produced would reverse the engine; but I could not succeed in doing so, and the only evidence of my repeated operations and attempts to do so seemed to be a little rounding of the corner of the indicator diagram before the ignition, showing a higher compression curve.

The engine had been driving the shafting and lathes in the shop all the morning. I applied a friction brake, consisting of a leather belt with spring balance and weights hung at ends on the fly-wheels, and measured the quantity of lubricating oil (the fuel used) in the cistern before and after a run of one hour. This oil, of specific gravity .854, was very much like the Scotch intermediate shale oil. The little governor effectively regulated the oil supply, by lifting a valve, and allowing the pump to force the charge back into the cistern instead of into the combustion chamber when

the speed was too high. By using a large fly-wheel and high speed (216 revolutions per minute), the regularity of running, with ordinary Otto cycle of operations—under full load and then light—was much better than I could have expected. In order to secure uniform speed for electric lighting purposes, the tendency is in this direction, and as I take it, rightly too, to use larger fly-wheels on gas-engines, and run at higher speeds than heretofore.

The brake wheel was 5 feet $4\frac{1}{2}$ inches in diameter, the net weight was gradually increased from 65 $\frac{1}{2}$ lb. to 70 lb. and 71.5 lb., whilst indicator diagrams (Fig. 13, p. 506) were taken, but, unfortunately, the spring available was not strong enough to get thoroughly reliable curves. The average brake horse-power came to 7.6 horse-power, whilst considerably less than 7 pints of this oil was used in one hour. The oil consumption thus works out to much less than a pint per *brake* horse-power per hour. The *exhaust* was *perfectly clean*, showing complete combustion, and this could not be otherwise, seeing that the oil was injected into a red-hot chamber filled with a supply of compressed air, ample to furnish the necessary oxygen for combustion.

The action in the engine cylinder is here entirely different from that in the Priestman, inasmuch as there is an excess of air in the cylinder, and this is compressed before the oil is injected. Consequently, the combustion will be complete, even when very heavy oils of great heating power are used. However, since the air is dry, the cylinder requires independent lubrication, as in the case of the gas-engine.

The oil consumption of this engine, when running without any load, is of some importance from a practical standpoint. I have ascertained that the 6 horse-power running light, uses $2\frac{1}{2}$ gallons in 10 hours; the small one in the show rooms here in London, consumes one gallon of oil for eight hours' run daily; and a 3 horse-power engine driving all the shafting for about ten lathes and machine tools, consumes $3\frac{1}{2}$ gallons during 12 hours' running light.

Even heavier oils might almost be tried; whilst the hot water from the water-jacket might go to warm up the oil, and keep it in a sufficiently fluid state fit for use.

A glance at the drawings affords evidence of the simplicity of the construction.

This engine is now being made by the important firm of Messrs. Hornsby and Sons,

Grantham, and promises well to contest the field with the Priestman.

KNIGHT OIL-ENGINE.

I must not omit to mention another oil¹ engine, that invented by Mr. J. H. Knight, of Farnham, Surrey, which has been in the market for several years. Here the vaporising chamber is placed at the rear of the cylinder, and kept hot by contact with the burning mixture in the cylinder. The firing arrangement is quite novel and unique. A pair of bellows, worked by the engine, makes a flame play at the proper moment on a spiral of platinum wire carried by a slide. However, for out-door work, when exposed to the winds and weather, the ordinary tube ignition is found better.

The engine is of the three-cycle type, like the Griffin gas-engine, using high piston speed, 300 revolutions per minute, with a 9" stroke. The ordinary Russian kerosene oil is used, and the consumption is stated to be only a fraction of a gallon per brake horse-power in actual work.

YARROW SPIRIT LAUNCH.

The use of petroleum, instead of coals and steam, separately as fuel and evaporating agent, is illustrated in the Yarrow spirit launches.

As already pointed out, owing to the difficulty and danger in transport and storage of the highly volatile spirit, this should only be used in the evaporating coil and engine cylinder, condensed, and the same spirit used over and over again, due provision being made against leakage, which, as a matter of fact, is very small, provided everything is in proper working order. This spirit gives a higher pressure than steam for the same temperature (see Fig. 8, p. 503) and may be cooled, by its own expansion during work, through a much wider range. It can be readily evaporated, and hence its convenience for this special use.

In a 30 feet launch, having a speed of 8 miles an hour, the oil ("Tea-rose") consumption is at the rate of 1.5 gallon an hour. These yachts are very handy, and all the trouble and inconvenience of coal ashes, dust, &c., is saved, and they can be started at a moment's notice. Besides the compact arrangement of oil-tanks in bow, and balancing engine in stern, leaves the whole midship available for passengers.

Sometimes part of this spirit is also burned as the fuel, but ordinary kerosene, such as "Tea-rose" brand, is not only much cheaper, but has also greater heating power. In a

special experiment, made to test the relative heating values of "Tea-rose" and this petroleum spirit of specific gravity .680, both fuels were burnt in a Rippengille's stove; and the amount of heat generated was measured by the weight of water evaporated by each fuel during a trial of three hours. The average in such trials showed an evaporative power for kerosene of 6.38 lbs. of water from and at 212° F. per 1 lb. of oil, and that for the spirit, 5.6 lb. of water per lb. of fuel, or only about 88 per cent. that of the kerosene, both fuels being burnt under similar conditions.

This arrangement of spirit engine is well adapted for pleasure yachts, but its use is not recommended for torpedo boats, or any craft where the stoke-hole is closed up, for fear of an accumulation of the spirit. Up till now, Messrs. Yarrow have only built open launches. Indicator diagrams from the little 3-cylinder engines are shown on the wall.

OIL-GAS.

It is now becoming pretty generally recognised that for large powers, above 30 or 40 horse-power the ordinary vaporisers in petroleum oil engines are difficult and troublesome to work with, even though they offer special facilities for the application of the Stirling regenerative principle to utilise the waste heat in the water-jacket and exhaust, as we have seen in small oil-engines.

In fact for large engines the practical plan obviously is to convert oil into gas by means of a gas-producer. Oil-gas, when cooled, can be used with great economy in the engine cylinder.

Further, a very decided saving in fuel may be effected by this combination of oil gas producer with the internal combustion engine, in place of the boiler and steam engine, in many places where suitable oil is cheap or plentiful, or where intermittent work is required. On the other hand, more heat may be produced by the direct combustion of liquid fuel with dry steam and air, than by first converting the oil into gas before using it as a fuel. This is obvious, when we bear in mind that it is impossible to create energy by any round-about process, however mysterious; and that there is necessarily some loss in all methods of gasifying fuel.

Oil-gas is now generally made from Scotch Intermediate shale oil, partially refined petroleum, mutton fat, waste grease drippings, and such like heavy oils and fats that are not available for use in the ordinary oil-engine cylinder, and may be had at low prices.

Such heavy liquid is passed in a thin stream, usually through a syphon pipe, into hot quarters, where it is vaporised in a retort at a cherry-red heat, which decomposes and converts the vapour into a "fixed" or permanent gas. This gas is then allowed to pass freely through a wide pipe into a hydraulic main filled with water, which separates the tarry products, and after further washing and cooling, without any pressure being applied, the oil-gas is led to the gas-holder,¹ where it is further cooled and stored ready for use. The quality of the gas, and the number of cubic feet obtained per gallon of oil, depend upon the temperature of the retort, as well as upon the rate at which the oil is run into it. In fact, every oil requires special treatment in order to give the best and largest yield of gas.

I must protest against the erroneous idea of oil-gas being made by air-gas machines—air-carburetting devices which use highly volatile gasoline, benzoline, and petroleum spirit, and mix the vapour that arises from them with atmospheric air by means of a fan driven by weights, like a clock, or otherwise. This spirit (for it is not oil) is highly inflammable and dangerous. It is not gas that arises from it, but vapour; consequently, like all vapour, it condenses again at moderately low temperatures when subjected to pressure; besides, it explodes and causes serious mischief when least expected. I do not recommend the use of such a carburetter with gas-engines.

On the other hand, gas-oil made by splitting up by heat intermediate shale oil and the like oils, into a real and fixed gas, does not condense again appreciably at the coldest temperature in winter. Real oil-gas does not possess the dangerous and troublesome qualities above referred to. Moreover, in case it escapes from a leaky pipe, it can at once be detected by its strong smell, like coal gas.

In this respect oil-gas is superior to water, gas, which is scarcely perceptible by its smell, and in consequently requires to be odourised; otherwise, water gas will by degrees imperceptibly overpower and poison those inhaling it, due to the presence of carbonic oxide.

Oil-gas, then, is a safe, rich, permanent gas made from petroleum oil, and burned with excellent results in the gas-engine cylinder.

MANSFIELD OIL-GAS PRODUCER.

The Mansfield oil-gas producer, of which sectional drawing is shown on the wall, is one of the oldest, simplest, and most extensively used apparatus of its kind.

The oil or melted fat is allowed to trickle down from the oil-cistern through the syphon bend into the pipe leading into the retort. In this pipe the oil is vapourised, and this, at still higher temperatures (cherry-red heat) in the retort, becomes thoroughly split up, and converted into a "fixed" or permanent gas, which escapes through the large bonnet into the downpipe, to the hydraulic main, where it is washed and cooled under ordinary pressure. It is most important that the least possible resistance be offered to the gas as it leaves the retort, and until it is washed and cooled. After that it can be stored in a gas holder ready for use in the gas-engine cylinder.

Any of the Scotch intermediate shale oils, varying in specific gravity from '840 to '865, may be readily converted into a rich permanent gas by means of this producer. The price of the intermediate shale oil mostly employed is £5 per ton at the Scotch oil works.

In ordinary working, the yield is 100 cubic feet of gas per gallon; and the Crossley engine consumes 9 cubic feet per hour per actual horse-power. The strong, rich gas is found to be sufficiently mixed with air for practically complete combustion, by simply admitting one-third the quantity of it that is usually admitted of coal gas. In Australia the squatter has mutton fat and dripping plentiful, and and this is readily converted into gas which gives excellent results in the Crossley "Otto" gas-engine.

KEITH OIL-GAS PRODUCER.

For larger installations, such as on Ailsa Craig rock, Firth of Clyde, and Langness Point, Isle of Man, we find the producer and complete arrangements of Mr. James Keith more applicable. The working model here on the table will readily enable you to understand this producer, of which you will find complete drawings and details in the paper read by Mr. David Alan Stevenson, before the Institution of Civil Engineers*. This working model, containing three retorts, will make three times 300, or 900 cubic feet of gas per hour from ordinary lighthouse oil.

At Ailsa Craig 10,000 cubic feet is made per 100 gallons of oil, using 20 to 30 cwt. of coal to heat retorts and make gas. This is found to be too rich to give thoroughly complete combustion, and especially the small burners for flame ignition gave some trouble. Hence Mr. Keith reduces the strength of the gas by dilution with air in Keith's mixers, 65 parts of

* See Proceedings Inst. C.E., vol. lxxxix., 1886-87.

gas to 35 of air, or roughly two of gas to one part of air, bringing down the strength to that of ordinary coal gas.

For small installations, Mr. Keith has designed a compact gas producer with one double retort.

Time will not permit me to do more than mention the Pintsch oil-gas system, which has also been described elsewhere. The yield of gas from this plant at the Great Eastern Railway Works, Stratford, varies from about 78 to 80 cubic feet of gas per gallon.

The west wall diagram shows a sectional view of the

THWAITE OIL-GAS GENERATOR,

Designed for the gasification of partially refined petroleum oils, intended for producing a gas suitable for motor purposes. This generator enables oil of an inferior value to that of internal-combustion engines to be used, but there is required a small addition of coke necessary for gasification, and supervising attention, which, is, however, little more than for an ordinary slow-combustion stove. It will be noticed that there is an annular fire-grate, in the centre of which is a vertical suspended tube, into which the oil is fed by gravity, descending through an inner centrally-fixed pipe, in which are fixed suspended bafflers and deflection, by which the oil is fed to inner sides of the central pipe and becomes partially volatilised. The suspended sediment falls into an inner grate and can be removed.

The gas flows through the annular space between the central pipe and the inner corrugated sides of the retort. The gasification is completed by the contact with internal side of heated retort. The heat radiated from the coke fire is partially transferred to the air traversing the the annular cavity built in side walls of furnace.

By this apparatus, de-hydrated petroleum at 3½d. per gallon is available for gas-engine purposes. With naphtha oil at 6d. per gallon, the cost of this 60 candle gas in gas-engine is 0·8d. per indicated horse-power to cover interest on cost of plant.

I must not omit to mention Mr. Thwaite's large gas generating plant as used at Southall gas works. The action depends upon thermolysis, that is, decomposition of hydrocarbon by heat, by which the oil is converted into a gas of fixed quality. The cycle of actions is novel. There are two generator vessels working in alternate unison; both vessels are charged with coke or coal, which

is fed into vessels by an ingenious and automatic contrivance, that not only elevates the fuel to the full height, but transmits it to the generators, into which it is fed regularly and certainly, and without loss of combustible gas. Over the fuel in each generator, into which during one part of the hydrocarbonaceous fuel generated in the vessels is consumed, and the products of the combustions are drawn through a flue (connecting the two vessels) into the second vessel, through the incandescent fuel of which the products of combustion (H_2O and CO_2) are drawn, being resolved in their descension into hydrogen and carbon-monoxide, which can be collected in a separate holder or be utilised for diluting the results of the volatilization of the petroleum. The cycle is alternately in one direction and then in another, the direction being reversed by automatic reversal valves. After four reversals, the air is shut off, the oil is then injected by special steam injector, and is immediately volatilised in one of the chambers, the oil-gas, along with the vapour of steam, flows through the connecting flue into the second vessel, in descending through the incandescent fuel in second generator; the oil gas is thermolytically decomposed into the higher of the hydrocarbon series, and is converted into a gas of a permanent character. This dissociation and permanent rearrangement is the result of a catalytic combination of the vapour of hydrocarbon with the vapour of water, and under a certain specific temperature, depending upon the temperature of the vapour of water, and the specific gravity of the injected oil. This injection of oil continues in the Thwaite generator as long as the temperature of the fuel does not fall below a certain limit. When this limit is approached the oil is shut off and the cycle already described is repeated. By this system the crudest oil is available for use, and the gas leaves the generator in a fairly permanent condition. The best measure of dilution of water gas gives from crude Russian oil (dehydrated) a gas of a photometric value of 27 candles. This oil costs £3 5s., delivered, and gives a gas the heating value of which enables a horse-power to be developed with expenditure of 20 cubic feet of gas.

LIQUID FUEL IN STEAM BOILERS.

The last but not the least important use of oil, is as liquid fuel for steam-raising purposes.

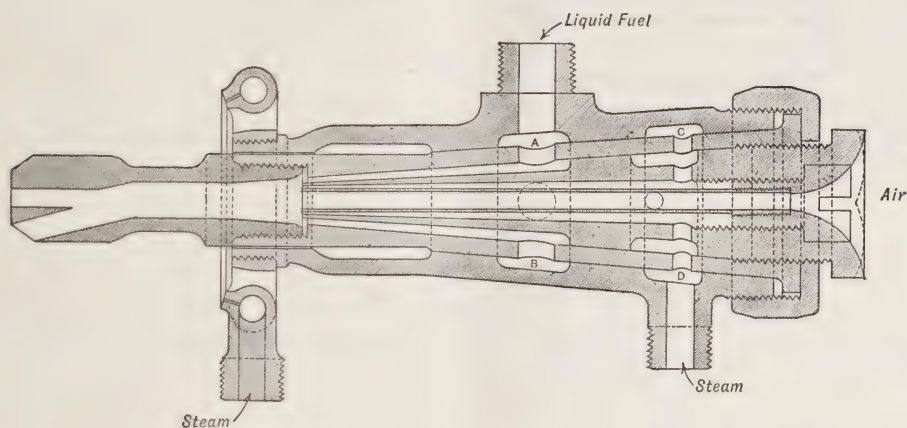
We have seen how heavy shale oils and mineral oils are converted into gas, but it

must be remembered that heavier oils still exist, creosote, common tar oil, blast furnace oil, and if you convert these into gas, you find the gas condenses again under ordinary conditions when subjected to pressure. These oils cannot be converted into *permanent* gas, and how are you to use them in prime motors? They may be used for steam-engines. You can use liquid oil as an ordinary fuel in this case, and by this means take advantage of the great improvements which have been made in steam-engines during the last half-century. This oil is obtained in abundance in Russia, and Mr. Thomas Urquhart, working under the most favourable conditions, has used numerous devices, and has at last obtained a most

satisfactory result by the use of the astatkai or residuum I have referred to.* We can have no more favourable conditions, as regards the quality of the material at command than the astatkai, which is very rich in heating power; and he found that whilst the maximum evaporation with this astatkai, from theoretical calculation, was 17 lbs. of water per lb. of petroleum, he could get an evaporation of 14 lbs. in his locomotive. That was as good as 82 per cent. of the total possible evaporation.

In this country we have not an abundant supply of this oil, and therefore we have to make the best of what exists, and that is what Mr. James Holden, locomotive superintendent of the Great Eastern Railway, has done. He can

FIG. 14.



HOLDEN'S INJECTOR.

have coal supplied at a fairly reasonable price, and also coal-tar and green oil sometimes at a reasonable price, but if he wants too large a quantity, very likely the price may go up, and he uses the one against the other. He has some of his express engines arranged so that he can use the one fuel or the other alternately, even during the same run. His injector (Fig. 14) is so arranged and proportioned that you can have the oil divided up as it is drawn in, by means of a steam jet, and still further divided by means of a ring which also provides steam jets. These play upon the oil and perform very much the same function as the air in the Priestman spray-maker here on the table. This can be fixed on the ordinary engine, with the same fire-box arrangement as for coal. It will be noticed that the injector proper is placed in a case, to facilitate removal or

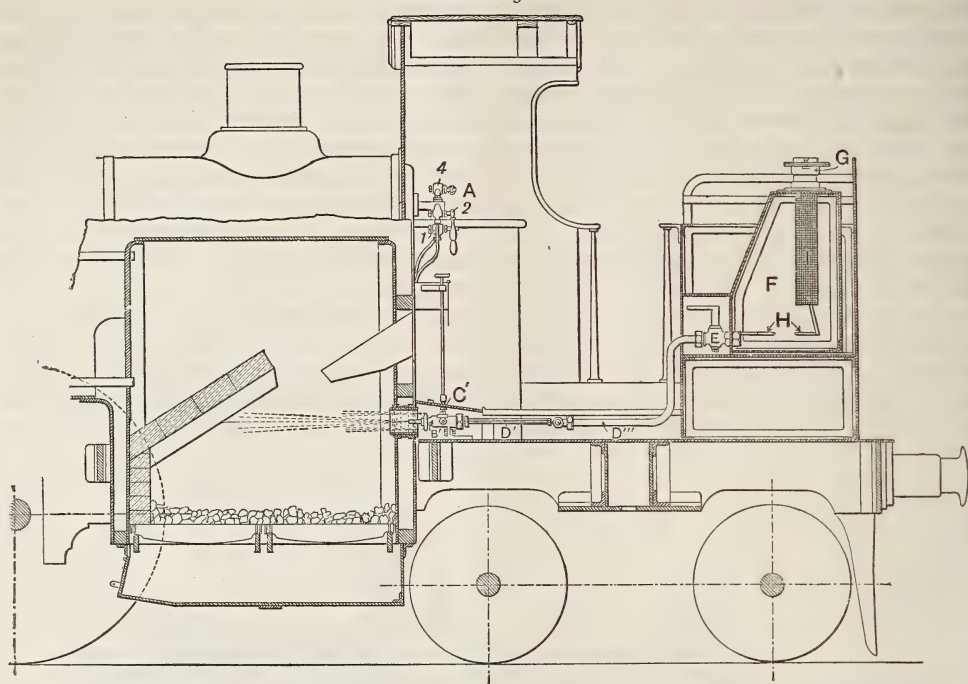
replacement if blocked or damaged on a journey.

There is on the wall a sectional elevation, Fig. 15, of the firing arrangement on the passenger tank locomotives. There is an oil tank **T**, as shown, and the oil flowing along **D** into the injector **C**, is forced by the steam jet into the open space above the fire-bars. On the fire-bars there is a very thin lining of incandescent fuel, consisting of cinders mixed with chalk, which keeps up the temperature, and is not merely for burning purposes, but can be retained during the day as an incandescent base on the fire-bars.

By this means Mr. Holden can use coal at one time in the engine, and the next run, if he likes, he can use a mixture of two parts of coal-tar and one of green oil just to thin it down.

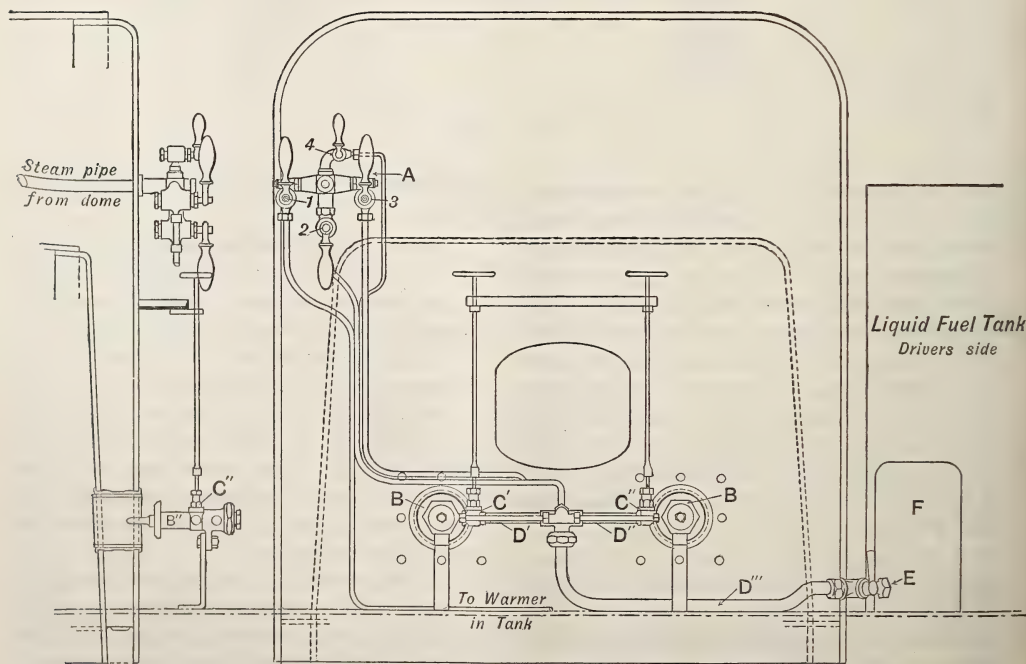
* See Proceedings of Inst. Mech. Eng., January, 1890.

FIG. 15.



HOLDEN'S OIL-FIRING IN LOCOMOTIVES.

FIG. 16.



INDIAN STATE OIL-TANK LOCOMOTIVE.

This mixture of coal-tar and green oil costs about 1½d. per gallon, or 25s. per ton. Hydrocarbon refuse, oil gas-tar, creosote and furnace oils are also used, and one ton of this is found to be nearly equal to two tons of steam coal, but all are inferior to either crude petroleum or petroleum residuum; as, on account of their greater weight, they require more steam for spraying, as well as being inferior in calorific value. At present, however, the price of petroleum is against its adoption in this country.

Mr. Holden has given me the following statement showing comparative consumption of fuels on stationary boilers and locomotives.

Coal, and liquid-fuel with coal; the coal used for lighting up being included in each case.

On a small Cornish boiler working at the Printing Dept., Stratford works:—

When fired with York's coal alone, the consumption is 121·3 lbs. per hour.

When fired with liquid fuel and coal, the consumption is—

Liquid fuel 35·1 lbs. per hour.

Coal 19·2 „ „

Coke 14·7 „ „

Total.... 69·0 „ „

On a vertical boiler in the Wagon Dept., Stratford:—

When fired with York's coal alone, the consumption is 77 lbs. per hour.

When fired with liquid fuel and coal, the consumption is—

Liquid fuel 38 lbs. per hour.

Coal 10 „ „

Total.... 48 „ „

On a stationary boiler of Locotype in Wagon Dept.:—

When fired with York's coal alone the consumption is 275·1 lbs. per hour.

When fired with liquid fuel and coal the consumption is—

Liquid fuel..... 99·3 lbs. per hour.

Coal 101·8 „ „

Total... 201·1 „ „

On an express engine with 7 ft. driving wheels, cylinder 18in. X 24in.:—

With liquid fuel and coal burns—

Liquid fuel 10·5 lbs. per mile.

Coal 15·0 „ „

Total.... 25·5 „ „

Average consumption of coal on 9 engines of same class, 34 lbs. per mile.

Holden's system of liquid fuel firing has

been adopted by the Government of the Argentine Republic, where the copious oil deposits are being developed. Fig. 16 shows on the right an end view of the eight coupled tank locomotives fitted with Holden's liquid fuel apparatus, and running on the Indian State Railways.

To the left of the same drawing (Fig. 16) is shown the ingenious arrangement for staying the boiler at the point where the injector is fitted, whilst at the top is seen the pipe from the dome conveying superheated steam to the injector. Dry steam gives much more complete combustion than when saturated with moisture, which tends to dull and blacken the fires. By closing the tap leading to the ring jets I could instantly stop complete combustion, and produce a cloud of smoke up the chimney, which on board ship might be used for signalling purposes.

This injector with liquid fuel firing in the steam ferry-boat *Middlesex* on the Thames gives the following consumption of fuel:—

Nineteen hours steaming per day.—Coal only, 1½ tons Welsh coal. Liquid fuel, 180 gallons (or 18 cwt.) liquid fuel (tar and green oil), and 2 cwt. coal for keeping fire in during night, total 1 ton.

INJECTORS.

We have a great number of other injectors. There are several on the table, which are used for atomising these heavy liquids into spray, and burning them in a furnace. Here is Mr. Thwaite's (Fig. 17, p. 514), which is rifled so as to give the liquid a spiral motion first of all, and then a steam spray is brought to play on it.

Here is also a large drum or trunk, devised by Mr. Thwaite and intended to use a minimum quantity of steam, by having a blast of air coming down a tube, and the steam and oil are injected down below. Only enough steam is admitted to spray the oil; the blast of air does the rest. Another drawing, Fig. 18, p. 514, shows Holden's oil injector used along with a forced blast of air, as used in the torpedo boat *Incognito*. The results obtained in this case are fairly satisfactory.

I wish to call your attention to the Bray-Smith injector. The first drawing here on the wall gives a section, showing how the steam is forced in, and draws the oil with it. The trouble in most of these injectors is that you hear a noise owing to the steam passing in. This can be lessened very much by putting an arrangement such as this enlarged perforated hollow drum at the end. Air can also be drawn in

FIG 17.—THWAITE'S INJECTOR.

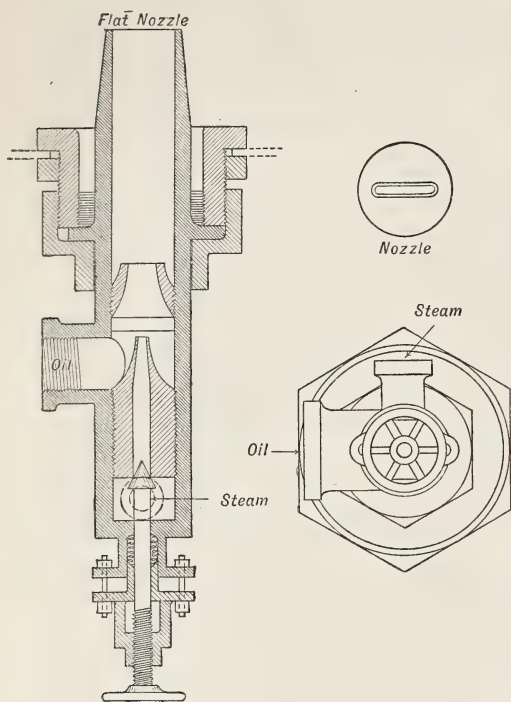


FIG. 18.—OIL FIRING IN TORPEDO BOAT.

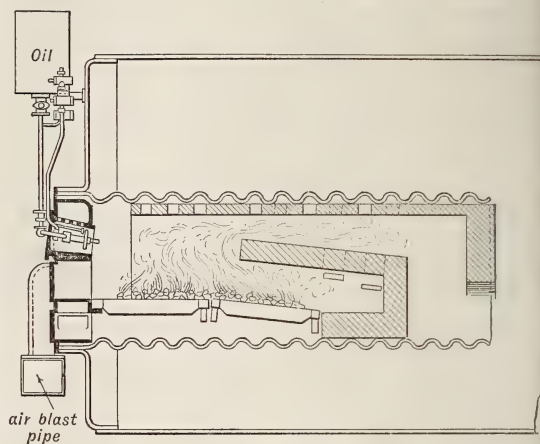
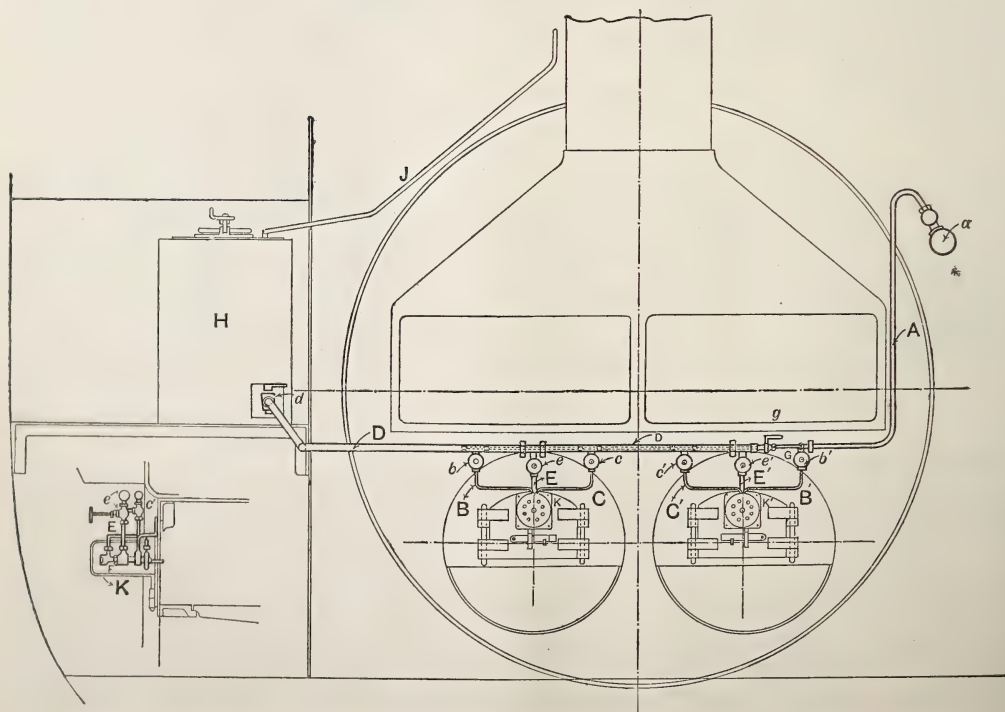


FIG. 19.—OIL FIRING IN STEAM FERRY "MIDDLESEX."



through these holes so as to still further atomise the oil and complete combustion. Across the end of the drum there are some rods to break up the oil jet still further, and by that means the liquid fuel can be thoroughly divided. This Bray-Smith burner is protected by a patent which has been favourably reported upon by Mr. Fletcher Moulton, Q.C., and is now in use in Russia; and Mr. Boverton Redwood tells me that he witnessed an experimental trial with it at Patricroft, Manchester, and formed a high opinion of it in respect to the character of the flame which it furnishes.

There are other oil injectors which I intended to dwell upon at considerable length, but there is not time left to do so. Here is Mr. Henwood's injector, which he has used for his small boat *Ruby*, of which you will see sections of the boiler on the wall. This is an exceedingly simple arrangement; you have in front a little stoppage in the central orifice to break up the oil, there are two conical tubes bringing down the oil and steam. This injector is small, and is made to give most remarkable results in practice.

I cannot leave this part of my subject without calling attention to this working model of Cornish boiler, indicating some modification or improvement in boilers when using liquid fuel. Of course there is a very high temperature in these boilers, and the result would apparently be to act injuriously on the plates of the boiler. But that is a mistake, it is not the high temperature merely, it is the frequent change of temperature that causes serious injury. If you can keep the boiler at a uniform temperature, and provided the plates are thin and there is a good circulation, so that the temperature is kept low inside, owing to the rapid circulation of the water you can use a fairly high temperature. Mr. Urquhart used thin copper tubes in some of his experiments with his locomotives, but I do not think he intends to continue them. This device of Mr. Thwaite, which he calls a *Saddle Circulator*, is to give thorough circulation in boilers of the Cornish and Lancashire type. There is a saddle fixed on the flue to direct the circulation, so that the heated water from below passes up through this space, and comes out at top, and so goes round over both sides. By that means you have circulation of the water round and round, giving remarkable results. There is no time for the sediment to get deposited; it is whirled

round and round, and kept in a finely-divided state.

There are, then, you see, at least three very important ways in which liquid petroleum can be used for generating power, and the only difficulty seems to be as regards the supply. I think this difficulty can also be got over, considering the widespread distribution of petroleum in the earth's crust in various countries. There are so many of these important oil-fields being opened up: of those that are known, many have yet to be developed; and there are, doubtless, many still remaining to be explored. It is of the greatest importance, therefore, that these great stores of energy or source of power in Nature should be directed to the use and convenience of man. This is supposed to be the duty of the engineer.

It is said that the sun never sets on the British dominions. Well, within such a wide realm there appear to be several countries containing oil fields where there may be abundant supplies to be worked up, and which will materially add to the native wealth of those possessions. We know that oil, as used in an engine under a boiler, will give, weight for weight, more evaporation than coal will, at any rate about twice as much. Consequently, you can have a store of oil in your steam-boat, and by that means you will be able to go twice as far, or get twice the evaporation. At the same time, if you take torpedo boats especially, you will have more complete combustion, and the smoke ought to be invisible. In the naval manœuvres which I witnessed about two years ago, I certainly did see smoke from a torpedo boat. Liquid fuel firing produces no smoke, unless you stop the steam supply to injectors, and by that means signal orders. Now, supposing there was a Russian torpedo boat fired with liquid astatki, and an English torpedo boat with ordinary Welsh coal. The one was manœuvring after the other, and the one could hold out twice as long as the other. What is the English boat to do when its coal runs short?

Apart altogether from the love of progress and advancement, we should, I think, bestir ourselves, actuated by mere selfish motives, to obtain our own comfort in time of peace, and security in case of war, being enabled, in times of peace, to take a sea voyage comfortably without being enveloped in smoke, and having the unpleasant sense of something very like ashes all around; and, in time of war, security in feeling that, whilst preserving the coal supply of the country for

future contingencies, our men-of-war and torpedo boats would be able to take on board the liquid fuel supplies of our foreign possessions as fuel at sea, and by that means be more than a match for any others of the same class in staying power.

DISCUSSION.

Mr. BOVERTON REDWOOD suggested that the results of the fractional distillation of different samples of oil would have been more useful if the experiments had been carried on in *vacuo*, or in an atmosphere of steam. He thought some of the irregularities observed were due to the dissociation of the hydrocarbons, which was liable to occur, especially at high temperatures, when the distillation was conducted under atmospheric pressure. That might afford some explanation of the difference commented upon between the irregular curves plotted from the results of the fractional distillation, and the regular curves indicating the results of the experiments conducted in the Torricellian vacuum. An attempt was made some years ago by MM. Salleron and Urbain to devise a method of testing petroleum for commercial and legal purposes, based on the principle of the latter experiments; and they obtained similar results, but they found that there was a practical objection to the employment of a test based on that principle, viz., that, although you might get certain results from one sample of petroleum, yet you might take another sample, having the same flashing point, but made up of different hydrocarbons, and obtain dissimilar results. Reversing the argument, it would not be possible to predict in all cases the flashing point of an oil by observing the curve produced by the depression of the mercury at different temperatures. He was glad the author had deprecated the employment of the lighter products of petroleum in engines of the gas-engine type, as there were grave disadvantages in the employment of liquids of that character. There was some risk in their conveyance, and in most countries there were restrictions imposed with respect to their storage and transport. In addition to that, there was always a liability to have charges unexploded in such engines, and in that way there would be a certain amount of these volatile hydro-carbons escaping into the air in a condition in which they might be dangerous. At an early stage of the introduction of the "Priestman" engine he had to make an examination of it, and recently acting on behalf of the Secretary of State, it was his duty to take part in an inquiry connected with its use at the bottom of a coal mine, one object being to determine whether the use of that engine was liable to create an inflammable atmosphere. The result was perfectly satisfactory, as might have been expected, from the fact that mineral oil, as distinguished from mineral spirit, was used in that engine. The objection to

the employment of mineral spirit did not so forcibly apply to such engines as those of Mr. Yarrow, where the liquid was practically in a closed chain, and could not escape. When he was in Russia, in 1884, he was much struck by the advantages obtained by the use of *astatki* with the ordinary injector burners. A great objection to burners of this type often was that they gave a pointed, or blow-pipe flame, which, if projected against a boiler plate, was liable to have a destructive effect. The Bray-Smith burner—and, probably, the same remark applied to the Holden burner—had been designed to produce a lambent rather than a blow-pipe flame. He recently saw the Bray-Smith burner in use at Patricroft, and found it produced a flame of the desired character.

Prof. UNWIN, F.R.S., said the author had given a great deal of useful information on points which would strike practical men as being most important. The point which occurred to him was the economy of petroleum in comparison with other fuels, and on that Professor Robinson had not said much, except a remark or two towards the end, in which he thought he must have misunderstood him. This question of the use of petroleum was almost always connected with certain theoretical fallacies, and he believed its calorific value was generally very much over-estimated. He did not know whether Prof. Robinson could help them, but he believed there was no method of determining exactly the absolute calorific value of petroleum oil. The best authorities he could find, some time ago, told him it was not possible to do so. In an approximate way you could do so, but at present there was no calorimeter to be trusted to give anything like a reasonable result. Knowing this, and knowing that at any rate there was a theoretical limit, according to the chemical composition of oil, he believed that the ordinary oils used for burning in furnaces could not have a calorific value of much more than 20 per cent. above that of coal. He could not agree with people who said that a pound of oil would evaporate as much as two or two and a-half times the same weight of coal. A short time ago, some American inventors brought a petroleum burner and asked him to try it, which, in an unguarded moment, he agreed to do; and the next thing he knew was that workmen were engaged connecting it to his boiler. He found that the insurance company raised an objection, and he feared that, in London, this would be a very serious matter. However, the burner was applied to another boiler, and tried with very favourable results. It was also tried by another engineer afterwards, with nearly the same results, and they found, as he expected from the chemical analysis, that it evaporated under very good conditions, as far as he could judge, there being a clear, and perfect combustion, and not too high a temperature—about 20 per cent. better than coal. That seemed to him something like the limit which

could be expected to be obtained in these cases. It was obvious that at the price at which even the roughest petroleum could be got, under such circumstances, petroleum oil could not supersede coal in this country for raising steam, except in very exceptional cases. Some time ago, he had an opportunity of trying the Priestman petroleum engine at the Plymouth Show, and was immensely surprised at the results obtained. It worked more quietly, steadily, and easily than the Otto gas engine. There was not the slightest hitch or difficulty about it during the whole time he had it under operation. As far as he could see, there was perfect combustion of the petroleum. There was no obvious vapour produced; the exhaust did not soil the handkerchief, and the engine worked with 1 lb. of oil per estimated horse-power per hour, which, he thought, was better than any steam engine, even making allowance for the greater calorific value of oil compared with coal. Being aware that, in the ordinary working of an engine, it did not work under the best possible conditions, he asked permission to try this engine under less favourable conditions, namely, at less than its normal power. This was accorded him, and he then found the engine worked with $1\frac{1}{2}$ lbs. of oil per horse-power per hour which was an extremely good result.

Mr. THWAITE said Mr. William Thompson, of Manchester, had obtained a fairly accurate test by a calorimeter of his own devising, which was found, when compared with a careful analysis of the same oil, to agree within 10 per cent., so that he thought such an instrument was a practical one. He believed Thompson used pumice stone, or some other substance which would absorb the oil, which he weighed, and then burnt it like ordinary fuel. With reference to what had been said with regard to the "Incognito" torpedo boat, there was here a slight deviation from ordinary practice. The Holden injector was placed inside the chamber, surrounded by a cavity into which air was blown under pressure, and consequently the air became heated, and passed through perforations round the injector, which helped to finely divide the oil. The result was, that it obtained very high efficiency of evaporation per square foot of heating surface, and it was a great improvement on the ordinary aspiration system. One defect on the part of this injector, which had never been thoroughly examined, was the amount of steam used by the ring. He did not know whether Mr. Holden calculated that, but it was an essential objection, though in other respects the injector gave very good results. With regard to benzoline and naphthalene, it was self-evident that if crude oil could be utilised, there was no reason whatever for using such dangerous products of distillation.

Mr. S. B. GOSLIN said he knew an instance in which the comparative cost of petroleum, as compared with coal for raising steam, had been very well illustrated. A friend of his had a corn-mill at Jerusalem, but he

found there was no wind at the time when it was most wanted, and as to raising steam by coal, the coal at Jaffa was £6 per ton, and it was found that in unloading the coal, about half of it was dropped into the water. His friend consulted him as to what he should do, and he advised him to use petroleum oil, with one of Mansfield's oil gas producers, as shown on the wall, and have a Crossley engine. He did so, with the very greatest success. There was a great difference between oil-gas when applied to motors and when used for lighting purposes; and Mr. Keith's elaborate arrangements which had been described in the paper* for purifying the gas by washing and condensing, were totally unnecessary in the case of motor-engines, saving a deal of expense. Some years ago, he saw a gas apparatus, of American invention, applied to the Shipway engine, which was exhibited in Hoxton, supplied with superheated water spray, and it was the most efficient means of utilising petroleum for generating steam. There was an automatic arrangement so regulated that, when the pressure required was obtained, the combustion was instantly stopped, but by means of a lamp placed in front, directly the pressure was lowered, ignition took place, and it started again. He had found in the case of heating water that there was a point after reaching which the temperature rose up rapidly to the boiling point, and he was not surprised to find that the same thing occurred with regard to oil. The practical point would be to find which oils could be turned into gas at the most convenient temperature, because those would be the most useful and economic in use.

Admiral SELWYN said, twenty-five years ago, in that hall, he was told distinctly by Dr. Benjamin Paul that coal could not be equalled at all by oil. After that the same gentleman allowed it might be equal to one and a half times, and since that he had come to Professor Robinson's idea, that its power was twice that of coal. For two years he (Admiral Selwyn) was running a 40-horse marine boiler in Whitehall-yard, evaporating 5040 lbs. of water with every 230 lbs. of oil used, and losing 27 lbs. of that oil by faulty arrangements. It might be interesting to hear of the experiment that determined the loss by radiation of that large boiler. With coal you had no constant temperature, and could not determine the loss by radiation, but he had the safety-valve weighted to 50 lbs. to the inch, and always kept to that. In this furnace, of which he found the injector was the very smallest and most unimportant matter, he found that exactly 27 lbs. of oil per hour would keep that boiler under 50 lbs. of steam without raising the valve for any number of hours. That was the value in oil that was lost by radiation. He was rather startled to hear that the temperature on the coast of South America was 78°. That must be the temperature of the water, the temperature of the air must be more nearly 120 or 130°, for he had been al

up and down the coast, and surveyed it with Sir Edward Belcher. He had always pointed out that, in an iron vessel, where the surrounding water was 90°, it was not a question of using light oils, which he could manage to do, but it was the carrying; he could not pack them absolutely tight in the tankers, there must be some escape of gas, and with a fire below the gas generated would be highly dangerous. While everybody must thoroughly appreciate Messrs. Yarrow's work in small open boats, he could not conceive that anybody could be so mad as to take on board a great man-of-war anything that could possibly generate gas, either at high or low flashing points. The question of quantity was the most important of all; and in these days no one could afford to depend upon a source or fuel which could not be obtained in the country itself. But he was happy to say that when, twenty years ago, he first turned his attention to this point, he found that we had in England more shale capable of giving 120 gallons of oil to the ton than we ever had of coal regarded as fuel. Whenever chemists would be kind enough to come and examine it, and he was able to go to the expense of setting up another 40-horse power boiler to do it, he would show how to get six times the value of coal. He quite recognised the chemist's idea that there was so much hydrogen to be turned to account, and you could not get more out of a cat than her skin would hold; it was not burning oil only, but as a preliminary to burning something else. He did not call it burning liquid fuel, but fluid fuel. He was prepared to do it as soon as it pleased the gentlemen chiefly concerned, namely, those connected with our shipping, either the navy or the mercantile marine. He would never listen to anyone who said you must take light oils. Had they calculated what a fire at sea was? With oil at a specific gravity superior to that of salt water, you could open the taps and let the oil run out, but if it were a light oil it would float to the surface, which would simply ensure the enveloping the ship in a sheet of flame within half an hour after it was done. He congratulated Professor Robinson on the accuracy of his investigations, and seeing the importance of this matter to this country, especially at the present time, when it was running ships at a loss and getting no freights which paid, he should be delighted to aid, by any means in his power, in pursuing this subject. He had no interest in it except as a scientific man, and to any scientific man who would come to him, he should be delighted to put him in possession of everything he knew on the matter.

Mr. COLE pointed out that, in the strategic case of torpedo boats referred to in the paper, there would be the further advantage by the use of liquid fuel, that you would not require to clean any fires, nor would there be any stokers or coal-trimmers wanted.

The CHAIRMAN, in proposing a vote of thanks, said that, with a thoroughness characteristic of the

man, Professor Robinson had laid before them much valuable information regarding the nature and use of the various petroleum oils. The facts about the evaporation of the oils were very interesting, and showed that some were much more homogeneous than others. Some oil began at a very low temperature to give off vapour, and went on doing so continuously, which was certainly not homogeneous, whereas some were very homogeneous. He should like to know which would be the better for an internal combustion engine, to use an oil of a homogeneous character, or a mixed oil. Some years ago, when oil engines had not reached their present perfection, he was consulted on a point arising from experiments, where there was some difficulty in getting an injected oil to fire; and he suggested, by the analogy of the action of a very small percentage of coal dust, the combustion might be brought about by introducing a small percentage of lighter oil, so as to bring the mixture up to the flashing point. With regard to the calorific value of fuels, Professor Unwin had suggested that there was no exact measurement of the calorific value of petroleum, but in addition to that, he might point out that he had not come across any calorimeter which was capable of determining with accuracy the absolute heating value of any fuel. Those things which were used for determining the calorific power of coal could not be relied upon to 10 percent.; and seeing that now-a-days, in questions of physics, they expected to get accuracy within one-tenth of one per cent., he felt that this was a very backward state of affairs. Several indicator diagrams had been exhibited which indicated that in these oil-engines there were great oscillations of pressure, but as oil engines and gas-engines generally ran at high speeds, the error which the indicator itself introduced into the drawings became accentuated. Those enormous waves indicated immense variations which were really not true to the fact, but resulted from the indicator itself. He did not think there was a steam-engine indicator which was true within 2 per cent. But he believed a much simpler and improved form, on totally different principles, would soon be introduced, for his colleague, Prof. Perry, had been for some time working on one which appeared to be very successful, in which the moving parts weighed nothing, and would be actually dead beat, and which would give the information which no ordinary indicator would give, besides being capable of being applied to engines running very slowly as well as at high speeds. This subject of internal-combustion engines was one that English engineers had made almost peculiarly their own; and he had more than once expressed his regret that, in the science and art examinations, it was not recognised. The steam-engine was a recognised subject, but the more modern, and therefore the more important, subject of the gas engine was ignored. He wished the subject of the steam engine could be divided into two, making

the elementary stage more general, and dividing the honours stage into two distinct branches, either steam or gas engines, or gas and oil engines, in either of which the candidate might go up. Being at the head of one of the colleges of the City and Guilds' Institute, he thought he might claim some credit for that Institute in this matter. Not only had Professor Robinson helped them for some years, but Professor Perry had been for many years in the habit of giving courses of lectures on the steam engine; and as an evidence of the good results of those lectures, they had the Akroyd oil engine invented by a former assistant in the laboratory. That movement, therefore, which originated with the Society of Arts, had been able to produce some good effect in the promotion of this great branch of the science of engineering.

The vote of thanks having been carried unanimously,

Prof. ROBINSON, in reply, said he could not enter on the question of dissociation at that late hour. He did not know the data Prof. Unwin quoted from, but he certainly had practical data from experiments, which would show that the figures certainly far exceeded 20 per cent. in favour of liquid fuel. There was a little steamboat running on the Thames, which, in 19 hours of steaming per day, took $1\frac{1}{2}$ tons of Welsh coal, whilst of liquid fuel she took 18 cwt., and 2 cwt. of coal to keep the fire in during the night, making altogether 1 ton. Mr. Urquhart's figures were also the result of practical working on Russian railways of 143 locomotives, and they showed the much greater evaporative power of liquid fuel. He had also the figures obtained in ordinary working on the Great Eastern Railway, the result of which was that 10.5 lbs. of liquid fuel, plus 15 lbs. of coal, sufficed for an express engine per mile, whilst the average with steam coal on the same type of locomotive was 34 lbs. The results obtained in ordinary calorimeters were certainly not up to 1 per cent., and it must be remembered, as he had found when assisting the late Dr. Andrews as student in his laboratory in making some determination of the heat value of ordinary hydrogen and other substances, that in these experiments the conditions were so unlike those in practical work as could never be really attained in ordinary practice. But the practical results obtained with oil and gas engines fully justified the statements he had made. It was very important that the oil gas should be mixed thoroughly with air, otherwise some of the combustible material might escape. He was well aware of the life-work done by Admiral Selwyn, whose papers he had gone carefully through, and was fully prepared for his remarks, except when he spoke about six times the heating power of coal, which he thought was beyond anything hitherto obtained, and seemed to him to be quite as much as could be hoped for theoretically

from pure hydrogen. Regarding the temperature on the coast of Peru, he had merely quoted the figures given by Capt. Carmichael and others. With regard to the Chairman's inquiry as to which was the best kind of oil, he found there was always sufficient light material in these kerosene oils to cause ignition, and that therefore a homogenous oil, like the Lighthouse, was best in practice.

Miscellaneous.

BANANA PRODUCTION IN TROPICAL COUNTRIES.

The banana industry, which was only commenced in 1883, says the "Handbook of the American Republics," is becoming more and more important every day. The bananas, which grow spontaneously in the tropical countries, have been from that date an article of commerce. Formerly they were planted in the coffee plantations to shade the young trees and shelter the grains from the wind that would sweep down the unmaturing berry. The fruit of the banana was used to fatten pigs, or grew without any cultivation in the mountains and plains, thus going into absolute waste. Bananas principally come from the British West Indies, Cuba, Honduras, Costa Rica, Nicaragua, Guatemala, British Honduras, Colombia, Hawaiian Islands, Mexico, and Salvador. The labouring classes in these countries generally kept a few plants, and used the green fruit boiled with salt, or roasted on hot coals, instead of bread. The varieties of bananas are great, there being some twenty-five or thirty classes. The better ones are, when perfectly ripe, baked in an oven with a slow fire, after being peeled, and buttered along a longitudinal incision which is made in the fruit; thus prepared it is considered a delicious food. The production of this article, which was thus limited, has been greatly increased, due to the American fruit companies which began to fit up vessels to go to Mexico, Central America, Colombia, the Guianas, and the West Indies, making monthly trips, and paying heavy prices for the fruit. The sudden rise in the price of an article which was for the growers almost valueless, induced the latter to start small plantations. The success obtained on the trial, together with the moderate amount of capital, labour, and enterprise required, encouraged them and some foreign firms to establish large plantations. These are generally situated near the railways, on the banks of rivers, or on the coast, thus saving labour and expense for transshipment, and avoiding excessive handling of the fruit. The lands chosen for the production of the banana are those that contain extensive alluvial deposits, composed chiefly of blue clay impregnated with marine salt, and rich in decomposed vegetable

matter. On the large plantations, where more capital is expended and the labour is better organised, the trees are usually planted from twelve to fifteen feet apart, in the form of squares, and where irrigation is required, trenches are dug between them to admit the water passing through as often as it is necessary. In places where the rain is abundant, or where the soil is damp, the bananas grow best. It is generally at the end of nine months that the plants mature, and after that time the fruit can be gathered every week in the year, provided the plantation has been well kept, and has had a good start. All that time the trunk of the tree attains a height of eight or ten feet, and about thirty-six inches in girth. From the trunk, which is porous and yields an excellent fibre, palm-like branches are thrown out to the number of six or seven. The bunch of fruit appears at the juncture of the trunk and branches, and consists of from four to twelve of what are termed "hands," each hand having eight to twelve bananas on it. A bunch of eight hands or clusters is counted as a full bunch; while those that have from five to seven are taken as a half bunch; bunches not less than five hands are styled third class, the others respectively first and second class. From the root of this tree several shoots or suckers sprout, each of which in turn becomes a tree, and bears a bunch of bananas, or they may be transplanted. After the bunch has been cut, the tree is usually felled, in fact, the tree is more frequently cut to gather the fruit. The manner in which the banana is cultivated is most easy, as very little skill or labour is demanded, nature doing almost all the work. The first cost of planting an acre of land is from £10 to £12, the production being from 600 to 800 bunches to the acre, which makes a cost of about 3½d. to 4d. per bunch, and they are sold at the plantations to the American fruit companies for from 2s. to 2s. 6d. a bunch. They in turn sell them in the United States for from 4s. to 12s. per bunch.

Correspondence.

GASEOUS ILLUMINANTS.

Reading here, on this opposite side of the world, Professor Lewes's interesting Cantor Lectures on "Gaseous Illuminants," I am, as a Durham man—born and brought up amid the smoke of countless coke-ovens—naturally struck with his reference to the proved feasibility of saving the millions of cubic feet of gases which are hourly sent forth as waste to pollute the atmosphere, and extracting from them proportionate quantities of mineral oils and other useful products. Of course, it may be assumed that all that Professor Lewes says of the profitable

nature of such treatment of otherwise waste gases as he describes applies pretty equally, whether the ultimate use to which gas is to be put is for lighting or as fuel. Now that, thanks to the labours of such men as Mr. T. Fletcher, of Warrington, the laws governing the use of gaseous fuel are pretty well worked out, and the value of such fuel generally understood, may we not look forward with hope to the not far distant time when the great smoke question will be solved by a sort of scientific and commercial revolution, when coke-ovens and blast furnaces no longer befoul the atmosphere, but the escaping gas be conducted by one means or other to the places where they can be utilised, and there, whether with or without intermediate chemical transformations, burnt in lieu of coal? Let any one try to imagine the altered conditions of life in Sheffield, Leeds, or Manchester, if instead of burning so many million tons of coal each per annum, they had their big fuel-gas mains laid from the coal pits direct! The economical side of the subject is also worth considering. In Cleveland the price of pig iron has for many years been a question of halfpence per ton. For every ton of pig iron made about a ton of coke is required for smelting purposes; and if by the saving of otherwise waste products in the escaping gases a shilling or two per ton of coke could be saved—and on the evidence the supposition would seem to be reasonable—the effect on the iron trade would be enormous.

W. WILKINSON.

York, West Australia.
March 16th, 1891.

DECORATIVE PLASTER-WORK.

I have perused with much interest Mr. Robinson's description of the ancient uses of stucco, and his eloquent advocacy for its re-adoption.

While not desiring to dispute the favourable results which Mr. Robinson claims for it from an artistic point of view—though it is possible that these may be open to question—I would request permission to point to apparent contradictions of physical laws in his description of the constitution of the material.

He says that stucco is a superior kind of mortar, the lime being very carefully selected, carefully burned with wood, and very slowly slaked, and that, a long time before using it. He further mentions the admixture with the lime of rye-meal and various other organic substances.

As the amount of heat to which limestones or carbonate of lime should be exposed in order to obtain a thoroughly good oxide should be most regular—too much or too little having an equally bad effect—the necessarily unequable combustion of wood will be most dangerous in its results. But, apart from this, and assuming that a satisfactory oxide has been obtained, it is slaked and becomes a hydrate.

One of the most generally recognised properties of hydrate of calcium is that of absorbing carbonic acid from the atmosphere very rapidly. When the lime is mixed with sand and water, forming mortar, this absorption of carbonic acid is the process of "setting," by which the mortar gradually hardens. But the same absorption proceeds whether sand or water is added to the lime or not. In the latter case it rapidly returns to its former state, viz., carbonate of lime, and will be of no more efficacy as a binding agent than powdered chalk or whiting, which it closely resembles.

Scientific persons in using lime specify that it should be newly slaked, and in some instances the quicklime is brought on the work and slaked there.

There has never been any doubt in the engineering or architectural mind that lime rapidly loses its power of setting after being slaked. It is an evident contradiction, therefore, that for the purposes of stucco it should be used a long time after slaking. Mr. Robinson mentions the use by the Romans of marble dust. The marble was not calcined but pounded into a powder. This would be a carbonate of lime precisely similar in constitution to whiting or to the long-slaked lime Mr. Robinson mentions, but without any setting properties whatever.

The admixture with this of glutinous matter, as described, will doubtless form a hard substance, but it is not lime stucco or mortar, but is similar to the cheap composition used everywhere for making cheap ornamentation which is made from glue and whiting, and which is at once softened by the application of moisture and heat.

To mix glutinous matter with lime mortar is quite at variance with modern theory. Organic substances merely in mechanical combination with lime and sand is liable to the absorption of moisture, to decay or disintegration, and can have no other than a destructive effect upon the mixture. In this instance also engineers and architects are careful in specifying the admixture of lime with nothing but clean sharp sand.

The stucco described by Mr. Robinson is a material which, according to modern ideas, should be of an essentially unreliable nature; but its composition requires some further elucidation, and possibly some of your readers may be able to throw some further light on it.

R. HENRY BRUNTON,
Member Inst. C.E.

21, Wellington-street, Strand,
27th April, 1891.

Notes on Books.

OPTICAL PROJECTION. By Lewis Wright. Longmans, Green and Co. 1891.

This book may be considered as, to a large extent,

a continuation of the previous excellent book on "Light," published by the same author. It deals in a very complete manner with all the various applications of the optical lantern to exhibition purposes and scientific demonstrations. The first portion of the book deals very fully with the various appliances used; the lantern itself, the various means of illumination, screens, slides, carriers, and accessory apparatus. The oxy-hydrogen lamp, with its modifications, such as the ether light, is treated at great length; but Mr. Wright also devotes a sufficient amount of attention to the electric light. He gives a preference to the Brockie-Pell arc lamp, not, however, referring to one drawback which this lamp possesses, and that is, its inclined position causes it to take up a good deal more room in the lantern holder than the ordinary vertical lamp. The projection microscope, the development of which is to a large extent, due to Mr. Wright's own work, is treated at some length; and the last portion of the book is devoted to detailed instructions for performing a number of demonstrations by means of the lantern. These are classified according to the subjects to which they refer, separate chapters being devoted to Chemistry, Sound, Light, Polarised Light, Heat, Magnetism, &c. A portion of the book relating to the Light experiments is, to a certain extent, a repetition of some of the former book, but much of it appears to be new, and without such repetition the book would of course have been incomplete for those who did not possess the previous one.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock :—

MAY 6.—E. L. FLEMING, "The Sources and Applications of Borax."

MAY 13.—PROF. J. J. HUMMEL, "Fast and Fugitive Dyes." SIR OWEN ROBERTS, Treasurer of the Society, will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evening, at Eight o'clock :—

MAY 5.—CAPTAIN J. BUCHAN TELFER, R.N., "Armenia and its People." Sir CHARLES WILSON, K.C.B., K.C.M.G., F.R.S., will preside.

Tuesday afternoon, at Half-past Four o'clock :—

MAY 26.—C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

MAY 14.—THOMAS WARDLE, "Description of

the Growing Uses of Tussur Silk in the European textile Manufactures." The Lady EGERTON of TATTON will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Natural Foliage." Four lectures.

LECTURE IV.—MAY 4.—Shapes and objects to which decoration is applied—Selection of plants to suit the shapes—Treatment in panels, borders, and diapers—Treatment on independent objects—Technical treatments.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 4 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Hugh Stannus, "The Decorative Treatment of Natural Foliage." (Lecture IV.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m., Mr. S. B. L. Druce, "The Prevention of the Adulteration of Artificial Manures and Feeding Stuffs," and, time permitting, "Small Holdings."

Engineers', Westminster Town-hall, S.W., 7½ p.m., Mr. C. C. Carpenter, "Modern Coal Gas Manufacture."

Chemical Industry (London Section), Burlington-house, W., 8 p.m., Professor Dewar, and Mr. Boverton Redwood, "A Process for the Conversion of Heavy Mineral Oils into Lighter Hydrocarbons, suitable for Illuminating and other Purposes."

British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m., Papers by Mr. E. Charlesworth and Mr. J. Allen Brown.

TUESDAY, MAY 5 ... SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Captain Buchan Telfer, "Armenia and the Armenians."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. E. Klein, "Bacteria: their Nature and Functions." (Lecture II.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W.,

8 p.m. Mr. William Langdon, "Railway-Train Lighting."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archaeology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr.

Slater, "Remarks on the Fauna of British Central Africa." 2. Col. Beddome, "Descriptions of new Land Shells from the Indian Region." 3. The Hon. L. W. Rothschild, "Description of a new Pigeon of the genus *Carpophaga*."

WEDNESDAY, MAY 6 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr E. L. Fleming, "The Sources and Application of Borax."

Geological, Burlington-house, W., 8 p.m.

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 3 p.m. Discussion of Mr. P. Jensen's paper, "A Few Notes on the Patent-office Library."

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, MAY 7 ... Linnean, Burlington-house, W., 8 p.m.

1. Mr. Malcolm Laurie, "The Anatomy of the Genera *Ptyogotus* and *Slimonia*, their relationship to the recent *Drachnida*." 2. M. Cresse Potter, "Observation on the Diseases of the Cocoa-nut (*Cocos nucifera*)."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. Dunstan and Mr. T. S. Dymon, "The Action of Alkalies or the Nitro-compounds of the Paraffin Series." 2. Professor Purdie and W. Marshall, "The Addition of the Elements of Alcohol to the Ethereal Salts of Unsaturated Acids." 3. Prof. Emerson Reynolds, "Some new addition Compounds of Thiocarbamide, affording evidence of its constitution." 4. "The Action of Anhydride on substituted Thiocarbamides, and an Improved Method of preparing Aromatic Mustard Oils." 5

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m., Mr. R. A. Sterndale, "Cyclopean Architecture in Polynesia."

Royal Institution, Albemarle-street, W., 8 p.m., Prof. Dewar, "Recent Spectroscopic Investigation." (Lecture V.)

Electrical Engineers, 25, Great George-street, S.W.

1. Dr. J. A. Fleming, "On some effects of Alternating-Current Flow in Conductors having Capacity and Self-Induction." 2. Mr. W. H. Preece, "Some Points connected with Mains for Electrical Lighting."

Archæological Association, 32, Sackville-street, W., 8 p.m.

FRIDAY, MAY 8 ... United Service Inst., Whitehall-yard, 3 p.m.

Royal Institution, Albemarle-street, W., 8 p.m.

Weekly Meeting. 9 p.m. Prof. W. Ramsay, "Liquids and Gases."

Civil Engineers, 25, Great George-street, S.W. 7½ p.m. (Students' Meeting.) Mr. J. Walter Brown, "Malta Dockyard Caisson."

Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m.

Paper by Mr. R. C. Moulton.

Physical, Science Schools, South Kensington, S.W. 5 p.m.

SATURDAY, MAY 9 ... Botanic, Inner Circle, Regent's-park N.W., 3½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m.

Mr. H. Graham Harris, "The Artificial Production of Cold." (Lecture I.)

Journal of the Society of Arts.

No. 2,007. VOL. XXXIX.

FRIDAY, MAY 8, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. HUGH STANNUS delivered the fourth and last lecture of his course on "The Decorative Treatment of Natural Foliage," on Monday evening, 4th inst. The lecturer treated of the shapes and objects to which decoration is applied, and of the selection of plants to suit these shapes. He also enlarged on the different methods of treatment necessary for panels, borders, and friezes.

On the motion of the CHAIRMAN (Mr. Hunter Donaldson), a vote of thanks was passed to Mr. Stannus for his course of lectures.

The lectures will be printed in the *Journal* during the autumn recess.

CONVERSAZIONE.

The Society's Conversazione is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 17th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

Further particulars as to arrangements will be announced in future numbers of the *Journal*.

EXAMINATIONS, 1891.

The list of successful candidates in the Examinations for the present year is being printed, and will be forwarded to Institutions in Union with the next number of the *Journal*.

Proceedings of the Society.

INDIAN SECTION.

Thursday afternoon, April 30th, 1891; The Right Hon. Sir MOUNTSTUART GRANT DUFF, G.C.S.I., C.I.E., in the chair.

The paper read was "The Periar Irrigation Project, Madras Presidency," By Col. J. O. HASTED, R.E.

The paper will be printed in a future number of the *Journal*.

FOREIGN & COLONIAL SECTION.

Tuesday evening, May 5th, 1891; Sir CHARLES WILSON, K.C.B., K.C.M.G., F.R.S., in the chair.

The paper read was "Armenia and the Armenians," by Captain J. BUCHAN TELFER, R.N.

The paper will be printed in a future number of the *Journal*.

TWENTIETH ORDINARY MEETING.

Wednesday, 6th May, 1891; FREDERICK WILLIAM RUDLER in the chair.

The following candidates were proposed for election as members of the Society:—

Furnivall, Willoughby Charles, 29, Devonshire-place, Portland-place, W.

Greenhough, David W., 5, Rood-lane, E.C.

Savery, Charles E., 153, Tachbrook-street, S.W.

Stuart, Herbert Akroyd, Bletchley, Bucks.

Tunstall, Wilmot, Brook's House, Meltham Mills, near Huddersfield.

The following candidates were balloted for, and duly elected members of the Society:—

Bayley, Sir Steuart Colvin, K.C.S.I., C.I.E., 7, Glendower-place, S.W.

Cornett, James Porteus, Claxheugh-grove, near Sunderland.

Dunford, J. Williams, 100C, Queen Victoria-street, E.C.; and Linda, Pembroke-road, Walthamstow, Essex.

Vallance, Robert Frank, Cavendish-house, Mansfield.

The paper read was—

THE SOURCES AND APPLICATIONS OF BORAX.

By E. L. FLEMING.

Borax is a white, crystalline substance, peculiar to the mineral kingdom; it is a very mild alkali, of a pleasant sweetish taste, and is not injurious to the human system; it is freely soluble in water; its solution acts as a solvent for resins, albumens, fatty acids, and certain organic bodies that are not soluble in water alone; but it does not appear to attack fibres, membranes, tissue, or skin. In the crystalline state, or in solution, it is very easily decomposed by such acids as tartaric acid or acetic acid; but in its calcined or anhydrous state, when fused, the boracic acid it contains acts as a more powerful acid than even sulphuric acid. Borax in the crystalline state contains $47\frac{1}{4}$ per cent. of its weight of water, to which it tenaciously adheres at the ordinary temperature of the atmosphere, time seeming to have very little effect upon its character. At the boiling point of water it slowly parts with nearly the whole of this water, and if the process be conducted quickly, at a still higher temperature, the borax swells to several times its size, becoming a body of a light and porous nature, which may be crushed to a compact powder. At a higher temperature than 450° Fahr. it melts to a clear glass, which remains transparent on cooling. Though the applications of borax are not generally known, as a fact this interesting and valuable salt will be seen to be utilised in different ways by several industries, which are so numerous and important that it may be convenient to group them under different heads, and again specify the classes of each group. These groups may be considered under the heads of Hardware, Earthenware, Chemicals, Textiles, Leather and Food.

In order to demonstrate the application of borax under each group, various representative firms have very kindly furnished specimens, in order to show the way in which it is used in their particular industry, and these specimens are now displayed on the table before you. It must not be taken for granted that every one in each particular trade uses borax, I only mention this to avoid being misunderstood. In the hardware industries it is used by goldsmiths, coppersmiths, ironworkers, safe-makers, machinists, and metallurgists. For goldsmiths a special grade of borax is prepared, called jewellers' borax, in pieces as

solid and free from cracks as possible, so that when rubbed on a slate with water it is not liable to fall to pieces, but will gradually wear away until too small to handle conveniently, when the small pieces are put on one side, to be used as a flux in melting or collecting.

The manner in which borax is used in soldering gold-work is as follows:—A piece of borax is rubbed on a slab of slate with a small quantity of water until a rather creamy mixture results, and parts of the work are dipped in this, and the small pieces of solder applied by the aid of a camel's-hair pencil moistened in the solution. The solder is then caused to melt by a quick blast from a blow-pipe.

In brazing copper it is used for cleansing the parts to be joined, on account of the property it possesses of dissolving the oxides that form a film upon the metal. It is very extensively used in the manufacture of copper pipes and for other purposes.

In welding iron and steel together it answers the same purpose. Machinists and others use the crystal for chilling the iron to the right temperature, for the purpose of case-hardening or tempering different portions of machinery or implements to the desired degree.

An enamelled coating for cast-iron and steel as well as copper is made by fusing on the metal a mixture of quartz, felspar, clay, and borax, and then covering it with a glaze containing borax. It is thus extensively used in the manufacture of enamelled iron mantelpieces, made to represent the rarest marbles, and in the great variety of enamelled signs and hollow ware. Borax is also used in conjunction with infusorial earth, for lining fireproof safes, for being a salt that contains nearly fifty per cent. of its weight of water of crystallization with which it parts at a high temperature in the event of fire, the steam arising from the heated borax permeates the books and papers in the safe, and prevents their being burnt. For this purpose it is superior to alum, which is an acid salt, and has a tendency to corrode the iron. At a red heat the boracic acid in borax readily dissolves, and unites with metallic oxides, forming a fusible glass, which property renders borax of great use in conjunction with other fluxes, for certain mineral and metallurgical processes.

In the earthenware industries it is used by manufacturers of imitation gems, glass, china, earthenware and cement. In the manufacture of "strass," which is the base of artificial

gems, borax is mixed with puresilex, potash and white lead; and put into a hessian crucible and kept at the highest heat of a pottery furnace for twenty-four hours. The longer it is kept in a state of fusion, the clearer and more homogeneous it will be when cooled. For coloured gems various metallic oxides are added, in proportions only learned by experience. The colouring matter must be in the finest powder, and not only very intimately mixed, but the mixture must be very strongly heated, the heat must be long continued and the cooling gradual. In the manufacture of glass it is not a necessary ingredient, but when used it is the strongest flux known.

In the specimen before us, it is contained in both the opal and flint metals. In the brilliant yellow glass of Sévres it forms over 10 per cent. of the component parts. It is used for staining glass different colours.

Borax has recently been applied with considerable success to the manufacture of optical glass at Jena. This glass has very high refractive properties, and has been very successfully applied to the manufacture of lenses for microscopes and for photography.

Borax is now used in glazing china and earthenware so extensively all over the world, that the consumption in these industries, at the present time, exceeds any of the others. The principle adopted is to form a fusible glass of borax and other materials, and fuse it on to the baked earthenware. Many formulas have been published of the composition of this fret, but almost every large firm have their own formula.

In the manufacture of Parian cement, the borax is added for the purpose of enabling the cement, when set and moulded, to take a polish.

In the chemical industries, it is used in the manufacture of soap, colours, drysaltery, and cosmetics; also in photography and timber-preserving.

There are many kinds of borax soap. From all accounts, its use in this industry arose from the fact that the linen of Holland and Belgium became celebrated on account of its superior whiteness, in the cleansing of which borax was used as a soap-powder; and hence we find that dry soap, soft soap, and toilet soaps are now made with it.

In the manufacture of colours borax is used, in the preparation of borate of chromium, a pale green powder, and borate of copper, a darker green. These are used as substitutes for arsenical green in painting and dyeing.

In drysaltery, it is used in the shape of borate of lead and borate of manganese. Both these products are used in the manufacture of varnish (as driers). The borate of lead is used for the palest varnishes, and the borate of manganese in other varnishes.

As a cosmetic, it enters into the composition of many preparations for the hair, the face, and the hands.

Photographers use it in the toning bath, to govern the action of chloride of gold, which is dissolved in conjunction with it, for changing the colour of a photographic print from the first, or red colour, to a beautiful brown or black. It is also used as a water varnish, to give a gloss to collotype prints. Also, in the Woodbury printing process, a sheet of paper for printing on is first rubbed all over on one side with a solution of borax, and then floated on a solution of shellac; when dried, it is ready for printing on.

In the preservation of timber, it is used for dissolving the albuminous resinous matter, or the sap, which readily decays, leaving only the tough fibre.

Borax dissolves caseine, forming a substance which can be used as mucilage.

In the textile industries, it is used in the manufacture of silk, calico, lace, hats, candlewicks, linen, and paper.

In silk, it serves for dissolving the glutinous matter adhering to raw silk.

In calico printing, it is used for fixing certain colours as a mordant.

Laces, muslin, tulle, and other light fabrics steeped in a solution of borax are rendered fireproof.

Hat manufacturers use borax for dissolving shellac to form a stiffening for felt hats made of wool. A weak solution of borax is used after the felt body is proofed, to wash from the surface any excess of stiffening not required upon the face of the felt.

Candlewicks are prepared with a solution of borax. Its use is to cause the wick to curve in burning, and at the same time to vitrify the ash. It also prevents the wicks from burning too rapidly, and obviates the necessity for snuffers.

In starching linen it acts as an economiser of starch, giving a clearness and stiffness as well as a glaze to the goods.

In the manufacture of paper and cards it is also used in glazing. To obtain this glazed finish, a solution of shellac and borax is floated over the surface, which is afterwards subjected to very heavy pressure.

In the leather industries, it is used in curing and preparing skins, by leather dressers, and leather dyers. This sheepskin rug has been sent by a manufacturer, who states that borax was used amongst other ingredients in preparing it.

It is used as a mordant in dyeing leather with aniline colours. And also in polishing, a little borax in the blacking or colour is added to enable the iron used in polishing to pass freely over the leather. It prevents the iron sticking, and increases the glaze.

In the food industries it is used by pork-packers, fish-curers, grocers, glacialine manufacturers, and druggists.

Pork-packers use powdered borax for sprinkling over hams and bacon; thousands of tons of meat are thus annually preserved in America.

Fish curers use a mixture of boracic acid, alum, and salt for keeping herrings fresh. The principal seat of this industry, so far, has been at Hangoesund, near Stavanger, in Norway.

Grocers supply borax for culinary purposes, and glacialine manufacturers use borax in their preparations for keeping milk.

Druggists use it in the preparation of at least a dozen drugs, such as borax lozenges, borax pastilles, and *mel boracis*, or borax and honey.

Having thus practically demonstrated its usefulness, let us turn our attention to the sources from whence it comes. England has no borax fields or mines, and at present the material, either in the manufactured state or that from which it can be manufactured, comes from Thibet, Italy, Chili, California, and Asia Minor. Thibet is the most ancient source, and under the name of "tincal" borax is brought from the neighbourhood of Yam-dok-cho to Calcutta, from which port the source of origin is distant between 400 and 500 miles almost direct north. At the present time there is railroad communication as far as Darjeeling, or a distance of 300 miles.

There is also a borax refinery at Jagadhri, 37 miles south-east of Umballa, in Northern India. All the borax which is exported from India is brought from the Trans-Himalayan region.

Stretching from Ladak, or Leh, eastward as far as Lhasa, along the course of the Sutlej and Brahmaputra, are a line of lakes about a thousand miles in length, and it is from this district that the tincal comes. The deposits of borax are invariably associated with sulphates, and carbonate of soda, with

more or less chloride of sodium and earthy matters, from which the tincal is mechanically separated by the natives, and packed in small woollen bags, holding 25 lbs. to 30 lbs. each. It is transported across the mountains to the highways of commerce upon the backs of sheep.

The supply from this source has never been very extensive, owing to climatic influences, the difficulties of transport, and the competition from other sources. According to the official returns, it appears that, in 1883, 1,201 tons were exported from India, whilst in 1887, only 714 tons were exported. The quality of the tincal varies from 65 per cent. to 90 per cent. of pure borax.

The Italian source of borax is crude boracic acid, the development of which, by the grandfather of the present Count Larderel, in the year 1818, is a matter of history. The boracic acid springs are situated in the Pomarance district of the province of Pisa, sixty-five miles south-east from Leghorn.

In the volcanic districts in Tuscany, there are many places where jets of steam are thrown up which are charged with boracic acid. These are known as *soffioni*. The steam is condensed by being passed through water in basins. The water is evaporated by the heat of the *soffioni*, and the acid thus obtained. Between 500 and 600 people are engaged in the industry, and it is stated that the expense of producing a ton of boracic acid of commerce amounts to £15.

The average composition of the crude material, taken from samples of 5,000 tons over three years, shows it to consist of $83\frac{1}{2}$ per cent. of pure crystallised boracic acid, which is equivalent to $128\frac{1}{2}$ per cent. of borax; that is to say, with the addition of soda and water, 100 parts of crude Italian boracic acid will produce $128\frac{1}{2}$ parts of borax.

From the Board of Trade returns, the production of boracic acid in Italy, for three years 1884-86, showed an average of 2,445 tons per annum, which, converted into borax, would be 3,141 tons. Efforts have been made from time to time to increase the supply of boracic acid without success.

There is railroad communication to within about eight miles of the works. The acid, packed in large casks weighing 13 cwt., is hauled to the railroad station on two-wheeled carts drawn by a mule or pony, two casks, and sometimes only one, forming a load. In the distance these ponies with their loads winding

round the country roads look like ants carrying a grain of corn.

In the year 1836, a double borate of lime and soda was found near Iquique in Peru. It is a silky fibrous substance, which looks very much like asbestos. It was identified by Ulex, after whom it has been called "ulexite." When pure, it is capable of yielding a very large percentage of borax, but it is generally associated with sulphate of lime, sulphate of soda, and common salt. It is found in nodules, from the size of a hazel nut to a large pumpkin, embedded in the marsh or lagoon, under an upper crust of sand and salt varying in thickness of from one to five inches. Large quantities of this borate of lime have been shipped from Iquique, Antofogasta, and Caldera.

The borate, when first dug out of the marsh, is rather moist, and the lumps are left lying exposed to the sun's action to dry. Mr. Robotom, who has just returned from Chili, states that the largest deposits of borate of lime are situated at Ascotan, in the province of Potosi, Bolivia, latitude 21° S., longitude 68° W. There is a railroad running past the deposit down to Antofogasta, a distance of 300 miles, the freight to point of shipment being 25s. per ton. The Ascotan lagoon is 12,090 feet above the sea level, it is 25 miles long, with an average width of from three or six miles.

The borate is made into borax and boracic acid at Antofogasta, where there is a large and well regulated works.

About 50 miles south-east of Iquique, 14 miles from Pica, at the foot of the Pintadas mountains, there is another deposit of borate. There is also a deposit at Maricunga, to the north of Copiapo, the shipping point for which is Caldera.

The raw material contains, on the average, 25 per cent. of boracic acid, equivalent to 68 per cent. of borax.

The annual production of borate of lime in Chili and Bolivia is estimated at 4,500 tons, equivalent to 3,000 tons of borax.

The Californian source, with which is associated Nevada and Oregon, is probably the most prolific in borax minerals of any section of the globe. Whatever you find in other borax-producing countries you find here, viz., tincal, boracic acid, double borate of lime and soda, and sesquiborate of lime. Borax was first discovered in California in the year 1856, by Dr. John A. Veatch.

Of tincal, or crude borax, there are no less than ten deposits, or borax marshes, as they

are called. Five of these are situated in California, and five in the neighbouring State of Nevada.

The Californian marshes are situated at Saline Valley, Furnace Creek, and Armagosa, all in the county of Inyo, Slate Range, in San Bernardino county; and Lower Lake, in Lake county. The Nevada marshes are at Rhodes, Teel's Marsh, Fish Lake, and Columbus, in the county of Esmeralda, and Salt Wells, in Churchill county.

Besides these borax deposits, there are deposits of double borate of lime at Rhodes and Columbus, in Nevada and Death Valley, in California. And also mines of sesquiborate of lime at Dagget, in San Bernardino county, at Death Valley, in Inyo county, California, and at Chetco, in Oregon.

The general view of a borax marsh is perhaps best illustrated by a photograph, and, for this purpose, we will throw on the screen a photograph of the Saline Valley borax marsh.

This marsh, which is one of the richest in the State of California, is situated on the eastern slope of the Sierra Nevada mountains, 11 miles from the line of the Carson and Colorado railroad, and 220 miles east of San Francisco; the valley is 18 miles long by 12 miles wide. The crude borax covers the plain to the extent of over a thousand acres, with a depth of from 6 inches to 18 inches.

The borax is mixed with sand, sulphate of soda, carbonate of soda and salt. The colour of the crude material, as it lays upon the plain, is of a peculiar greyish yellow, giving the surface the appearance of snow, somewhat tinged by age. The material varies in richness from 10 to 90 per cent. of pure borax.

The next photograph will show the crude method adopted in refining the borax. The plant consists of long semicircular iron pans, into which the material is thrown, the pans are boiled by fires underneath, and when the solution is of the required strength, after settling for a few hours to allow the solid matters to subside, the clear liquor is run off into vats to crystallise, which takes about a week; and the crystallisation being complete, the mother liquors are decanted, and the borax removed and packed. The process is so simple that Indians are employed in borax-refining. The next two photographs will show groups of these natives; they belong to the Pah Ute tribe, and very good fellows they are: they are paid a dollar a day.

The cost of obtaining a ton of borax at the marsh amounts to £3 10s., in addition to

which there is hauling and railroad, and freight to the market.

The Death Valley borax marsh lies a little to the south-east of Saline Valley, and more remote from the railroad. Death Valley takes its name from the circumstance of a company of emigrants entering it, on their way from Salt Lake to California, in the year 1850. Very little was known then of the passes through the mountains, and this party made the fatal mistake of attempting a more direct pass, than that by the well-known emigrant road. The valley was to them a *cul de sac*. While seeking an outlet, they experienced dangers and difficulties altogether unexpected and almost insurmountable. Finding it impossible to take their wagons over the mountains, they abandoned them, and while some of the party climbed the rugged and roadless passes, others, seeking water, miserably perished.

In this valley, and also at Calico in San Bernardino, there exist mines of sesquiborate of lime, or borate spar. This borate lies in ledges varying in thickness from 6 inches to 6 or 7 feet, and crops out at the surface at different angles.

The photographs now exhibited on the screen will best explain the manner in which this borate occurs.

The borate is mined in the ordinary manner by sinking shafts and running levels.

The material is carefully picked and freed from the limestone, gypsum, and steatite with which it is associated, when it yields a product containing from 35 per cent. to 40 per cent. boracic acid, and can be converted into its own weight of borax.

There are three kinds of sesquiborate of lime that correspond to the three varieties of carbonate of lime, viz., calc spar, marble and chalk. In many instances it is extremely difficult to distinguish by the eye the difference between the borate and the carbonate.

Prospectors for borax and borates frequently use a little sulphuric acid and alcohol to detect their presence; the boracic acid liberated by the acid gives with alcohol, upon ignition, a beautiful green flame. If you have no means of obtaining these, a little vinegar and whisky will give the same result.

These three varieties of sesquiborate of lime are worked in Oregon, California, and Asia Minor.

At Chetco, Oregon, the borate of lime occurs in large, beautifully white nodules, imbedded in a soft serpentine formation this; variety is similar to chalk.

The borate spar of California is similar to calc spar, and the boracite of Asia Minor may be likened to marble.

At the present time, the production of borax on the Pacific coast amounts to 6,000 tons per annum, most, if not all, of which is consumed within the limits of the United States.

The next and last source is that from Asia Minor. Boracite, as it is called, was discovered in 1869 at Sultan Chairi, near Suzurlu, in Asia Minor, forty-five miles from Panderma, a port on the Sea of Marmora, 100 miles from Constantinople, with which city there is a regular service of steamboats.

The principal deposits, as far as yet known, exist near the Tschatalja mountain, in longitude $28^{\circ}2'$ east, and latitude 40° north. It is mined by means of both shafts and tunnels. The boraciferous stratum varies in depth, the nodules or borate being disseminated through the gypsum and other earthy impurities with which it is associated, and from which it has to be selected and picked. The material is hauled to Panderma in "arabas," or native ox-carts, or else packed on the back of camels. It tests from 40 to 44 per cent. of boric acid. The present annual yield is from 8,000 to 9,000 tons.

There are other minerals existing in different parts of the globe that contain boracic acid, but either the quantity, the quality, or other difficulty exists that prevent their being dealt with commercially. They are interesting mineralogically.

The manufacture of borax, as far as the English are concerned, divides itself into two classes—the manufacture of borax from boracic acid, and that from sesquiborate of lime and double borate of lime and soda.

The mere refining or recrystallizing of crude borax requires no skill at all. The manufacture of borax from boracic acid imported from Italy involves several processes. The sulphates of ammonia and magnesia have first to be washed out of the crystallized acid, and this is effected by reason of their superior solubility. The boracic acid is then boiled in large iron pans, with the requisite amount of carbonate of soda, the impurities allowed to subside, and the clear liquor run to large iron vats to crystallize. This first borax is not pure enough for commerce, and requires a second crystallization.

The impure borax liquors are boiled down, and upon reaching a strength of 60° Twad., or 1,300 specific gravity, are allowed to recrystallize and throw down a further crop of

borax. Before the mixture reaches a temperature of 80° Fahr. it is drawn off into other vats to allow the sulphate of soda to crystallize out, and, finally, the liquor is raised to the boiling point, and concentrated in order to get rid of the common salt.

Borax manufactured from boracic acid is liable to be tinged with various colours, such as black, green, or yellow, on account of impurities contained in the acid or the soda ash, and are due to the presence of sulphides or oxides of iron. In order to overcome this difficulty the borax is bleached when in a state of solution.

The manufacture of borax from boracite, colemanite, or ulexite, presents a new feature that does not appear in the manufacture from boracic acid, and that is, that when any of these minerals are reduced to a state of the finest powder, and boiled with carbonate of soda, what is known as borate of soda, as well as baborate of soda, is formed.

The baborate of soda or borax crystallizes out in the ordinary way, but the borate of soda remains as a thick syrupy liquor, which has to be decomposed either with carbonic acid, boracic acid, or bicarbonate of soda. If this is not done loss is apt to occur, and the full strength of the mineral is not obtained.

With such abundant and redundant supplies of borate of lime throughout the world, it becomes a question of transporting the boracic acid it contains in as concentrated a form as possible, especially in those regions where the quality is but poor, and, therefore, many plans have been devised. One of the simplest is what is known as the sulphurous acid process, and this is to be preferred to others on account of the small quantity of sulphur required to extract the boracic acid.

The process consists in burning sulphur, and injecting the sulphurous vapours into the decomposing vessel, where the borate of lime is kept in a state of agitation and suspension in water.

Only one ton of sulphur is required to produce five tons of acid, and the saving effected in cost of transportation, where it takes two or even three tons of borate of lime to produce a ton of boracic acid, requires no recommendation.

The price or value of borax has probably interfered to a great extent with its more general use. The fluctuation can be better described by a diagram on the wall, and shows the value in London and New York for the last twenty years.

In 1872, owing to a combination, the price

was forced up to over £100 a ton, since which time, owing to the American and Asia Minor supply becoming developed, the price has declined, increased, and declined again. And at the present time the curious circumstance exists that the price of borax in America is higher than it is in England. America, of all places in the world! The way it came about was this. Prior to 1883, Italian boracic acid was admitted into the United States duty free; so some of the borax manufacturers applied to Congress to put on a duty, as it was ruining the borax industry. This Congress obligingly consented to do, and put on a duty of 4 cents a pound. There has been a duty on borax of foreign manufacture all along; but American borax, shipped from San Francisco to New York, *via* Panama or round the Horn, is admitted duty free. Even if American borax is shipped from San Francisco to Liverpool, it can be re-shipped to America and admitted duty free. Still the price of borax in the United States went down until, in 1885, it was sold at £21 per ton in San Francisco. It then occurred to the borax producers to combine and put up prices, which in 1887 they did, limiting the production to the requirements of the United States, and selling to actual consumers in a few other countries. The price was put up to the full extent of the tariff on borate of lime and boracic acid. And so the consumers of borax in the United States, where there is probably more borax than any other section of the globe, have to pay more for it. You will notice that twenty-eight industries, owing to the action of the protection policy of the United States, thus suffer to benefit one.

But in order to maintain that price, the Americans are restricted to the consumption in their own country, for fear of their borax being bought at the current price in England, and shipped across to New York to compete with the higher prices there.

Various estimates have been made of the consumption of borax throughout the world, and one of the methods of ascertaining this is by referring to the productions of different countries, and converting the different materials into their equivalent of borax. We thus find the production to be as follows:—

	Tons.
Asia Minor	8,000
Thibet	2,000
Italy	3,000
United States	6,000
Chili and Bolivia	3,000
Total....	22,000

As the American and Asia Minor supply has been developed within the last 20 years, it will be seen that the uses of borax, to the extent of 14,000 tons per annum, have increased during that period, or nearly 300 per cent., and it may be taken for certain that its uses will still further extend.

DISCUSSION.

MR. ARTHUR ROBOTOM said he was neither a chemist nor a geologist, but he had travelled much in search of borax, feeling sure that its general use would be a great value to the world. He was the first to bring it from California, and having a large stock, of course he tried how he could dispose of it, and to what uses it could be put. He, therefore, induced the butcher in the village where he resided to let him have some cowhides, which he treated with borax, he then had them tanned, and sent the leather to Northampton, where it was pronounced to be as fine as any in the world; in fact one man was so pleased with it that he had kept a specimen in his window ever since. When he first went to America borax was little known there except to druggists, but he spoke about it, and got its uses noticed in the papers. Rambling in the Death Valley he saw a dead horse lying on the ground, and pulling out some of the hair and finding it perfectly firm he cut a piece of flesh with his knife and found it perfectly sweet, although, as he ascertained afterwards, the carcase had been lying there a long time. He got this noticed in the California papers, from which it was copied into others, and that was the beginning of the use of borax as a preserving agent in America, a use which had now become so general. With regard to its effects on the human system, he believed Sir Henry Thompson had spoken of it as deleterious, but he took it constantly, and was never-out of health, and he had cured many sore throats with it, for he always kept a supply of it about him. Sir Joseph Lister was the first to use it as an antiseptic in medicine, and if people could only be taught to use it in their socks it would be an immense boon to soldiers, policemen, postmen, and others who had a great deal of walking to do. The great difficulty was to get shopkeepers to sell it, but he did his best to make its virtues known. He had been in communication with hundreds of chemists on the subject, and he always endeavoured to find out what their customers said of it. The antiquity of tincal as an import from Thibet was considerable. He had reason to believe that it was brought by caravan from beyond Shata to China, and hence by way of Babylon and Palmyra to the Mediterranean ports before the Christian era. In 1707, the price of tincal in London was £9 5s. a cwt., or £185 a ton; and in July, 1756, from a price current, he found it was £14 a cwt., or £280 a ton.

Of course at such a price it could not be used for washing. The great thing to be desired was that it should be low in price so that washerwomen might use it instead of soda; they would not get sore arms, and if they had such, it would cure them. He had just returned from Chili and Bolivia. Near the Death Valley there was a deposit of crude borax, which he discovered about a foot under the blue mud. When this was removed, the borax was accessible; and when the sulphate of soda was dissolved out, it was tolerably pure. He sent a cargo of it home round Cape Horn, and felt very proud when it arrived. It was a very toilsome journey to get there, for there was no railway then; and he had 212 miles to walk, through a very difficult country; but he felt amply repaid, when he found the borax, knowing it would have the effect of bringing the price down, and putting it within the reach of all.

MR. OWEN asked if Mr. Fleming had any knowledge of a recent discovery of a large deposit of borax in Washington territory. He believed it was not generally known, but understood that the information was trustworthy.

SIR H. TRUEMAN WOOD said he might refer those interested in this subject to the paper read there, some few years ago, by the late Professor Barff,* on his invention of boro-glyceride, which he used very successfully as a food preservative. In the Society's *Journal* for 1860† there would also be found a full account of the Tuscan boracic acid districts, written by Mr. Jervis, an Englishman, who resided in Italy.

The CHAIRMAN, in proposing a vote of thanks to Mr. Fleming, said probably few present, before hearing the paper, had any idea of the number of uses to which this remarkable salt was applied. It appeared to be used for hats and boots: from head to foot they were indebted to it; and Mr. Robotom almost invited them to use it as a food in time of health, and as a medicine in sickness. Many of its applications were of special and technological interest only, but the suggestion that it might be used for making textile fabrics unflammable was of universal application, and if every housewife could be induced to employ it for this purpose in the manner described, dissolving one pound in a gallon of water, great advantage would result from the reading of the paper. It was very curious to note how enormously its application had extended in recent years, owing to the enlarged production. Going back to the beginning of the century, Thibet seemed to be the only source, tincal having been brought from there for untold ages. In the early part of the century, the remarkable district in Tuscany, to which Sir Henry Wood referred, made its contribution, and though the yield from thence was not now so large as from America or Asia Minor, it was very important.

* *Journal*, vol. xxx., p. 516. † Vol. viii. p. 542.

There were a number of vents in the ground giving forth boracic acid in the form of vapour, and the district which was once sterile and pestilential, had been converted by the exertions of Count Larderel and others into a great industrial centre. Mr. Jervis, whose account had been referred to, was educated at the Royal School of Mines, and had for many years held the post of Curator of the Technological Museum of Turin, and was the author of a most valuable work in four volumes, on the mineral resources of Italy. At the time of the Exhibition of 1851, the sources of borax, as appeared by the catalogue, were very few, and the supplies scanty, but some years afterwards a remarkable specimen was brought home by the late Mr. Bollaert, who travelled in Chili and Peru, which proved to be the double borate of lime and soda. It was called, in the first instance, Hayesine, and, owing to some difficulty in opening up the deposits, very little was heard of them for some time. Then came the discoveries in California, to which Mr. Fleming had referred. He remembered hearing of them first from the late John Arthur Phillips, who visited Borax Lake, and in the last twenty years there had been a most remarkable development in the industry. The borax lake became impoverished in time, but other deposits were discovered, and the output now was enormous. Up to 1872, all the borax used in the United States was imported, but the opening of these deposits led to a prohibitory tariff being imposed, and America was now supplied from her own resources. He apprehended that many of the applications which had been mentioned were the result of American ingenuity, but he would be a bold man who would say that the utilities of borax had yet been exhausted. Mr. Fleming concluded his paper by suggesting that its use would be still further extended, and no doubt the paper would itself conduce very greatly to that end.

The vote of thanks having been carried unanimously,

Mr. FLEMING, in reply, said he considered it a great honour and privilege to be able to bring the matter forward; and, if his suggestion as to the fire-proofing fabrics were taken up, he should be abundantly repaid. In reply to Mr. Owen, he might say, that when in California some six months ago, he heard that some one had come down from Vancouver's Island, and stated that a deposit of borax had been discovered on the Canadian frontier, but that it was so remote from the railroad and shipping accommodation, that it was impossible at present to utilise it. That was the case with some other known deposits. There was a deposit of the double borate of lime and soda in Persia, but it was too remote from the sea or railway to do anything with it. With regard to the boracic acid springs of Italy, he had not

thought it necessary to say much, because they had been so thoroughly described in different chemical works. He had read with great interest and pleasure Mr. Jervis's work on the subject, and extracts from the work were sent over to California to Professor Hanks, of the State Mining Bureau, and copied into the annual report of the State mineralogist. The United States Consul in Leghorn also visited the district as recently as 1882, and he treated the matter exhaustively, though his report was only a recapitulation of what had been said by Mr. Jervis.

Correspondence.

DECORATIVE PLASTER WORK.

Mr. Brunton having made sundry comments in the *Journal* of the 1st May on my paper on "Modelled Stucco Work," I should like to offer a few brief explanatory remarks.

1st. As to the use of wood for burning lime. I was not advocating this, but simply quoting Vitruvius. I dare say this is an unscientific mode of calcining limestone, but it was the only one then available; and even now wood is used in the greater part of Europe for this purpose, the harder woods being preferred; but I do not find more "disastrous results" arising from such use than where coal is used.

2nd. In regarding stucco—meaning thereby a superior kind of mortar—from a civil engineer's point of view, and considering its cementitious quality only, Mr. Brunton is quite right in advocating the employment of newly slacked lime. My paper was solely devoted to the consideration of the plastic quality of stucco and its artistic use. To model in newly slacked lime would not only be dangerous to the artist's hands and eyes, but his work would crack, and fall to pieces as it dried. Again, for the purpose of fresco-painting, the caustic quality of "hot" lime would destroy most colours, and its efflorescence obliterate those which remained. It is quite evident, from the stress laid by all the old writers on this subject, that the need of lime slacked long before it was used was felt to be a very important fact; indeed, wherever stucco is now used, either for modelling or for painting in fresco upon, this caution is still insisted on and observed. Therefore, we can feel assured that all the old stucco work we have was so compounded. That this stucco work has stood for a very long time, the illustrations of my paper made evident by photographs of their actual state. It certainly was not of an "essentially unreliable nature."

3rd. As to the admixture of organic substances with the lime, Mr. Brunton's comment is correct if he

restricts it to the use of "glutinous substances," such as animal glue and size, which are readily soluble substances; but the only animal substances contained in the receipts quoted by me are blood and white of egg—that is, albuminous ones. Now "white of egg and quick-lime" is one of the hardest and most insoluble cements, and is well known in almost every household.

As to the virtue of vegetable admixtures quoted, such as I have experimented with do render the stucco easier to model with and apparently increases its hardness.

I do not pretend to sufficient chemical knowledge to venture upon any reason for this, but I shall be very grateful to any one better endowed with scientific attainments who will consider this question, and communicate the result of their research either to the *Journal* or to me.

GEO. T. ROBINSON.

20, Earl's-terrace, Kensington, W.

Among the many interesting points raised by Mr. G. T. Robinson in his paper on "Decorative Plaster Work," the composition of the material in which such work is to be executed naturally occupies a prominent position. To use a perishable material for such work would be to delay if not entirely prevent the resuscitation of the ancient art for which Mr. Robinson so ably pleads, and it is of the greatest importance that the composition of the stucco should, as far as possible, be above suspicion. The author of the paper gives us the result of ancient practice, which has stood the test of many centuries; but Mr. R. H. Brunton takes exception to several of the precautions specified on the ground that they are not in accordance with modern science or practice. I venture, however, to think that some of Mr. Brunton's remarks do not quite represent the state of modern knowledge on the subject. With regard to the burning of limestone or carbonate of lime, for instance, Mr. Brunton states that too much or too little heat has an injurious effect. This is only true of impure limestone, which would hardly be selected for such a purpose. Pure carbonate of lime may be subjected to the intense heat of the oxy-hydrogen blowpipe without losing its power of slaking when exposed to moist air, a fact but too well known to all who use the lime light. Even natural limestones of considerable purity can be exposed to the highest available temperatures without deterioration of the resulting hydrate; and I have myself exposed Buxton limestone to the intense white heat of a steel furnace, and subsequently found it to slake as well as the same stone burnt in the ordinary way. Should any of the limestone be insufficiently burnt, *i.e.*, should it still retain its carbonic acid, it will not slake, and the lumps can easily be separated from that which has been converted into a fine powder by the slaking

process. The use of wood for burning lime has the great advantage that it does not introduce the deleterious sulphur compounds present in all mineral fuels.

Mr. Brunton states that the process of "setting" is the absorption of carbonic acid. This is not at all in accordance with modern scientific research. The interesting experiments of Wolters and other observers have clearly proved that the presence of carbonic acid is not necessary for the setting of mortars, and that mortars will set perfectly well in an atmosphere quite free from carbonic acid. No doubt the ultimate hardness of mortars is much increased by the gradual absorption of carbonic acid; but the process is extremely slow, and as it requires several generations for its completion, we must not rely on it for modern work. Dr. Ziureck found a considerable per-centage of caustic lime in mortar 500 years old, and a sample of mortar from a bridge over the Great Western Railway, which was removed last month, and was about 50 years old, still contained 27 per cent. of the lime in a caustic state. Air-slaked lime does not absorb carbonic acid unless free water is present; this has now been known for more than twenty years, and yet, as Mr. Brunton remarks, some persons specify that lime shall be newly slaked. This is in direct contradiction, both to the practice of the ancients and modern scientific observation. There is a reason for the use of pulverised marble, which Mr. Brunton considers—I think erroneously—"precisely similar in constitution to whiting, or to the long-slaked lime Mr. Robinson mentions." Marble, even in the finest particles, is crystalline in structure; and it is a fact, well known to chemists, that a particle of a crystalline substance will often produce crystallisation, when added to a mass of identical chemical composition, but amorphous in structure. It is, therefore, highly probable that the presence of these crystalline particles in mortar may cause the carbonate of lime, which is slowly formed, to assume the crystalline structure; and, as this is the final and most permanent form of all mineral substances, the result is, no doubt, favourable as regards the permanence of the mortar.

With regard to the admixture of glue with *whiting*, this could hardly be very desirable; but *caustic* lime would have a very different chemical action on the glue. I have used for many years for painting woodwork, out-of-doors, a mixture of blood and caustic lime, which mixture is much more desirable than a wash of lime or even Portland cement; and yet the blood alone is very unstable substance.

I trust these remarks may tend to give a little more confidence in the material which, it appears to me, Mr. Brunton rather underrates.

WALTER F. REID, F.I.C., F.C.S.

Fieldside, Addlestone,
May 6, 1891.

PETROLEUM IN MOTORS.

In the report of my remarks after the reading of Professor Robinson's paper, there are two small changes of expression which almost invert my meaning. I am reported as saying that I had tried a petroleum burner in a steam boiler "with very favourable results." What I said was, "in very favourable conditions." I do not think the result was at all favourable to the use of petroleum in raising steam. I am reported as saying that there was "a clear and perfect combustion, and not too high a temperature." What I said was that there was "a clear flame, perfect combustion, and not too high a temperature of the waste gases in the chimney."

In this trial the effective evaporation (deducting the steam used for the burner) was 10·44 lbs. of feed water at 71°·4 per lb. of petroleum oil. This is equivalent to an evaporation of 12·16 lbs. from, and at 212° per lb. of oil. From previous trials of the same boiler with Welsh coal, I judge the evaporation per lb. of oil to be 26 per cent. better than per lb. of coal. But this somewhat overestimates the difference of value of the fuels, because the boiler was forced more in the coal trials than in the oil trials.

As to experiments in which a boiler is worked one day with coal and another day with oil, without exact measurements of the amount of evaporation, anyone experienced in boiler trials will know that such experiments are fallacious and misleading. They are not only of no scientific value, but they are useless even in forming a rough practical judgment of the relative value of two fuels. Apart even from the uncertainty whether the same work was being done on both days, it is necessary to know whether the boiler was so designed and used that a fairly good result was obtained. I am surprised that Professor Robinson should quote results of this kind and still more that he should base any conclusions on them.

W. C. UNWIN.

May 4th, 1891.

Obituary.

LOFTUS PERKINS.—By the death of Mr. Loftus Perkins, which took place on the 27th of April last, at Kilburn, the Society loses one who took a very active interest in its work, and was the representative of a family which has for long been closely associated with it. Mr. Perkins's grandfather, Jacob Perkins, an American by birth, who spent a large portion of his life in England, was a prolific and ingenious inventor. Jacob Perkins took out no less than 19 patents in the days previous to 1852, when each patent cost something over £200. The subjects dealt with included steam-engines, marine pro-

pulsion, cooking, the artificial manufacture of ice, artillery (the steam gun), and, perhaps the most important of all, the method of engraving by pressure, by which the identical plates from which postage stamps are printed were for a long time produced. Jacob Perkins received three gold and two silver medals from the Society of Arts, of which he was a member, for his inventions. His son, Mr. Angier Mark Perkins, was also a member of the Society, and as an inventor, hardly less distinguished than his father. He developed the system of heating by high-pressure water, in connection with which the firm of A. M. Perkins and Son has long been known. He also applied the same principle to the construction of fixed and portable baking ovens, which are largely used, the latter especially for commissariat purposes.

Mr. Loftus Perkins, the son of A. M. Perkins, and the subject of this notice, possessed his full share of the hereditary genius of his family. His most important inventions were in connection with high-pressure steam-engines. To him must undoubtedly be given the credit of being the pioneer in the use of high-pressure steam, and indeed the pressures which he used with perfect safety have never been attained by any other inventor. He appears to have been the first to enunciate and employ the principle of using steam at a pressure such as that of 500 lbs. on the square inch, and expanding it several times, so as to obtain a very large amount of power from a very small amount of steam. One of his engines was placed in the steam yacht *Anthracite*, and after the engine had been made the subject of a very careful and elaborate test by Sir Frederick Bramwell, the *Anthracite* crossed the Atlantic and returned, steaming the whole way—the very smallest steamer which has ever done this. The object of the experiment was to show, in a striking manner, the great economy of fuel obtained by the use of the Perkins engine and boiler. The high-pressure engine was, however, not a commercial success, for whether from ill-luck, or from whatever cause, it did not appear to work satisfactorily except in Mr. Perkins's own hands, or in the skilled hands of those trained by him. He also applied the high-pressure engine to traction on common roads, and an experimental engine, constructed for the purpose, made many successful road journeys. The latest subject to which his attention was devoted was the artificial reduction of temperature for industrial purposes. The *Arktos*, or freezing apparatus, invented by him was fully described in the fourth lecture of Mr. H. Graham Harris's Cantor course on "Heat Engines other than Steam."* The apparatus is one of the class in which ammonia is employed, a great reduction of temperature resulting from the vaporisation of the liquid ammonia produced by liquefaction of the gas after it has been driven off from its solution by moderate heat. The special feature of the Perkins' apparatus was that

* See *Journal*, vol. xxxvii., p. 776.

there were no moving parts in it. The incessant labour which he devoted to the perfection of this invention brought on a severe illness about a year ago, and from this he never recovered, though he had the satisfaction of seeing the invention in perfect working order before he broke down.

Mr. Perkins was born in 1834. Following the example of his grandfather and his father, he became a member of the Society, which he joined in 1877. From 1881 to 1883 he served upon the Council. Amongst those who knew him he was regarded with feelings of the warmest affection, for his kindly nature, his genial manners, and his generous character endeared him to all with whom he came in contact.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock :—

MAY 13.—PROF. J. J. HUMMEL, "Fast and Fugitive Dyes." SIR OWEN ROBERTS, Treasurer of the Society, will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoon, at Half-past Four o'clock :—

MAY 26.—C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

MAY 14.—THOMAS WARDLE, "Description of the Growing Uses of Tussur Silk in the European textile Manufactures." The Lady EGERTON of TATTON will preside.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MAY 12.—H. ARTHUR KENNEDY, "Glass Painting." LEWIS F. DAY will preside.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 11 ... North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m. Discussions. 1. Mr. W. Hök, "The Unsinkability of Cargo-Carrying Vessels." 2. Mr. Harry Gray, "Water-Gauge Fittings for Steam Boilers." 3. Mr. J. Petree, "The Basis of Ships' Scantlings." Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. G. S. Rolleston, "State-created Small Holdings."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Major C. M. Macdonald, "The Benue, and its Northern Tributary, the Kibbe."

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Sir William Dawson, "Stones of Ancient Egypt."

TUESDAY, MAY 12 ... SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. H. Arthur Kennedy, "Glass painting."

Society for the Encouragement and Preservation of Indian Art (at the HOUSE OF THE SOCIETY OF ARTS), 5 p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. E. Klein, "Bacteria : their Nature and Functions." (Lecture III.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 50, Great Russell-street, W.C. Mr. Leon Vidal, "Photographic Methods of obtaining Polychromatic Impressions."

Anthropological, 3, Hanover-square, W., 8½ p.m. Mr. Charles H. Read, "The Origin and Sacred Character of certain Forms of Ornament in the S.E. Pacific."

Colonial Institute, Whitehall Rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Mr. C. E. Howard Vincent, "Inter-British Trade."

WEDNESDAY, MAY 13 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor J. J. Hummel, "Fast and Fugitive Dyes."

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. First Summer Exhibition.

Guild and School of Handicraft, Mile End-road, Mr. R. B. Rathbone, "Hammered Hollow-wire."

Royal Literary Fund, 8 Adelphi-terrace, W.C., 3 p.m.

THURSDAY, MAY 14 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Thomas Wardle, "Description of the Growing Uses of Tussur Silk in the European Textile Manufactures."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 8 p.m. Prof. Dewar, "Recent Spectroscopic Investigations." (Lecture VI.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Dr. J. A. Fleming's paper, "Some effects of Alternating-Current Flow in Conductors having Capacity and Self-Induction," and Mr. W. H. Preece's paper, "Some Points connected with Mains for Electric Lighting."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Institute of Architecture, Science, and Art, Dundee, 8 p.m. Rev. James Cooper, "Principles of Christian Faith and Worship as applied to Structure and Adornment of Churches."

FRIDAY, MAY 15 ... United Service Inst., Whitehall-yard, 3 p.m.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Professor G. W. Liveing, "Crystallization."

Philological, University College, W.C., 8 p.m. Mr. Talfourd Ely, "Inscribed Vases."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, MAY 16 ... Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Graham Harris, "The Artificial Production of Cold." (Lecture II.)

Journal of the Society of Arts.

No. 2,008. VOL. XXXIX.

FRIDAY, MAY 15, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Conversazione is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 17th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

Further particulars as to arrangements will be announced in future numbers of the *Journal*.

EXAMINATIONS, 1891.

The list of successful candidates in the Examinations for the present year has been printed, and can be obtained on application to the Secretary. Copies are forwarded to the Institutions in Union with this week's number of the *Journal*.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 12, 1891; LEWIS F. DAY in the chair.

The paper read was "Glass Painting," by H. ARTHUR KENNEDY.

The paper will be printed in a future number of the *Journal*.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, 13th May, 1891; SIR OWEN ROBERTS, M.A., F.S.A., Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Anderson, Andrew Whitford, 46, Warwick-gardens, Kensington, W.

Corrie, D., Nobel's Explosives Company Limited, Polmont Station, N.B.

De Neufville, Richard, The Broom, Crystal Palace Park-road, Sydenham, S.E.

Ely, Bishop of (Lord Alwyne Compton), Ely-house, 37, Dover-street, W.

Hardman, Josiah, Milton, near Stoke-on-Trent.

Hicks, James, Redruth.

Slater, John, 46, Berners-street, W.

Wilson, Robert Henry, 202, Cromwell-road, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Cowburn, William Henry, 70, Market-street, Manchester.

Fauvel, Charles James, 12, George-street, Mansion-house, E.C., and 31, Camberwell-green, S.E.

Miranda, Señor Don Francis de, Tumbez, Peru, and 16, St. George's-terrace, Gloucester-road, S.W.

Richards, Thomas Robert, 25, Bedford-row, W.C.

Salter, Stephen, jun., Pondwell, near Ryde, Isle of Wight.

The paper read was—

FAST AND FUGITIVE DYES.

By PROF. J. J. HUMMEL.

As it is with many other arts, the origin of dyeing is shrouded in the obscurity of the past; but no doubt it was with the desire to attract his fellow, that man first began to imitate the variety of colour he saw around him in nature, and coloured his body or his dress.

Probably the first method of ornamenting textile fabrics was to stain them with the juices of fruits, or the flowers, leaves, stems, and roots of plants bruised with water, and we may reasonably assume that the primitive colours thus obtained would lack durability.

By and by, however, it was found possible to render some of the dyes more permanent, probably in the first instance, by the application of certain kinds of earth or mud, as we know to be practised by the Maori dyers of to-day, and in this way, as it appears to me, the early dyers learnt the efficacy of what we now call "mordants" which I may briefly describe as fixing agents for colouring matters.

At a very remote period therefore, I imagine, the subject of fast and fugitive dyes, engaged the attention of textile colourists.

Our European knowledge of dyeing seems to have come to us from the East, and although at first indigenous dyestuffs were largely employed, with the discovery of new countries many of these fell slowly and gradually into disuse, giving way to the newly imported dyestuffs of other lands, which possessed some advantage, being either richer in colouring matter, yielding brighter or faster colours, or being capable of more easy application. Thus kermes gave way to cochineal, woad to indigo, and so on.

Down to about the year 1856, natural dyestuffs alone, with but one or two exceptions, were employed by dyers; but in that year a present distinguished member of this Society, Dr. Perkin, astonished the scientific and industrial world by his epoch-making discovery of the coal-tar colour mauve. From that time down to the present, the textile colourist has had placed before him an ever-increasing number of colouring matters derived from the same source.

Specially worthy of notice are the discoveries of artificial alizarin, in 1868, by Graebe and Liebermann, and of indigotin, in 1878, by Adolf Baeyer, both colouring matters being identical with the respective dyes obtained from plants.

In view of the vast array of coal-tar colours now at our disposal, and their almost universal application in the decoration of all manner of textile fabrics, threatening even the continued use of well-known dye-stuffs of vegetable origin, it becomes of the greatest importance to examine most thoroughly, and to compare, the stability of both old and new colouring matters.

The first point in discussing this question of fast and fugitive dyes is to define the meaning of these terms, "fast" and "fugitive." Unfortunately, as frequently employed, they have no very definite signification. The great variety of textile fabrics to which colouring matters are applied, the different stages of manufacture at which the colouring matter is applied, and the many uses to which the fabrics are ultimately put, all these are elements which cause dyed colours to be exposed to the most varied influences.

The term, "a fast colour," then, may convey a different meaning to different individuals. To one it implies that the colour will not fade when exposed to light and atmospheric conditions; to another that it is not impoverished

by washing with soap and water; to a third it may indicate that the colour will withstand the action of certain manufacturing operations, such as scouring, milling, stoving, &c.; while a fourth person might be so exacting as to demand that a fast colour should resist all the varied influences I have named.

It is well to state at once that no dyed colour is absolutely fast, even to a single influence, and it certainly cannot pass unscathed through all the operations to which it may be necessary to submit individual colours applied to this or that material. Many colours are fast to washing or milling, and yet very fugitive to light; others are fast to light, but fugitive towards milling; while others again are fast to both influences. In short, each colour has its own special, characteristic properties, so that colours may be classified with respect to each particular influence, and may occupy a very different rank in the different arrangements.

It is, however, by no means necessary to demand absolute fastness from any colour. A colour may "bleed" in milling, and therefore be very unsuitable for tweeds, and yet be most excellent for curtains and hangings, because of its fastness to light. So, too, a dye capable of yielding rich or delicate tints, but only moderately fast to light, may still be perfectly well adapted for the silks and satins of the ball-room, or even the rapidly changing fashion, although it would be quite inadmissible for the pennon at the mast-head.

The colours of carpets, curtains, and tapestry should certainly be fast to light, but no one expects them to undergo the fatigue of the weekly wash-tub; and just as little as we look for the exposure of flannels and hosiery day by day, and week by week, to the glare of sunlight, much as we desire that the colours shall not run in washing.

For all practical purposes, then, it seems reasonable to define a "fast colour" as one which will not be materially affected by those influences to which, in the natural course of things, it will be submitted. Hence, in speaking, of a fast colour, it becomes necessary to refer specially to the particular influences which it resists before the term acquires a definite meaning. To be precise, one should say that a colour is "fast to light," or "fast to washing," or fast to light and washing," and so on. Further, it is necessary, as we shall see afterwards, to give always the name of the fibre to which the colour is applied.

All that I have said with respect to the term

"fast," may be applied with equal propriety to the term "fugitive." This, too, has no very definite meaning until a qualifying statement, such as I have referred to, gives it precision.

The most important question to be considered is

THE ACTION OF LIGHT ON DYED COLOURS.

That light can effect radical changes in many substances was known to the ancients. Its destructive action on artists' pigments, *e.g.*, the blackening of vermilion, was recorded 2000 years ago by Vitruvius. Since that time it has been well established, by numerous observations and experiments, that light possesses, in a high degree, the power of exerting chemical action, *i.e.*, causing the combination or decomposition of a large number of substances. The union of chlorine with hydrogen gas, the blackening of silver salts, the reduction of bichromate of potash and of certain ferric salts in contact with organic substances, are all familiar instances of the action of light. In illustration of this, I show here some calico-prints produced by first preparing the calico with a solution of potassium bichromate, then exposing the dried calico under a photographic negative, and, after washing, dyeing with alizarin or some similar colouring matter. During the exposure under the negative, the light has reduced and fixed the chromium salt upon certain parts of the fibre as insoluble chromate of chromium ($\text{Cr}_2\text{O}_3\text{CrO}_3$); in the more protected portions, the bichromate remains unchanged, and is subsequently removed by washing. During the dyeing process, the colouring matter combines with the chromium fixed on the fibre, and thus develops the coloured photograph.

The prints in Prussian-blue are produced in a similar manner, the sensitive salt with which the calico is prepared being ammonium-ferricitrate, and the developer potassium ferri-cyanide.

Investigation has shown that the most chemically active rays are those situated at the blue end of the solar spectrum; and although all the rays absorbed by a sensitive coloured body effect its change, it is doubtless the blue rays which are the chief cause of the fading of colours. Experiments are on record, indeed, which prove this.

Depierre and Clouet (1878-82) exposed a series of colours, printed and dyed on calico, to light which had passed through glasses stained red, orange, yellow, green, blue, and violet, corresponding to definite parts of the spectrum.

They found that the blue light possessed the greatest fading power, red light the least.

More recently (1886-88) Abney and Russell exposed water-colours under red, green, and blue glass, and came to the same conclusion.

But the chemical energy of the sun's rays is not the sole cause of the fading of colours. There are certain contributory causes as important as the light itself.

About fifty years ago, Chevreul showed what these accessory causes are, by exposing to light a number of dyed colours under varied conditions, *e.g.*, in a vacuum, in dry and moist hydrogen, dry and moist air, water vapour, and the ordinary atmosphere. He found that such fugitive colours as orchil, safflower, and indigo-carmine fade very rapidly in moist air, less rapidly in dry air, and that they experience little or no change in hydrogen or in a vacuum. The general conclusion arrived at was, that light, when acting alone, *i.e.*, without the aid of air and moisture, exercises a very feeble influence. Further, it was determined that air and moisture, without aid of light, have also comparatively little effect on dyed colours. Abney and Russell, in their experiments with water-colours, obtained similar results.

These conclusions are exactly in accordance with our common knowledge of the old-fashioned method of bleaching cotton and linen, in which the wetted fabric is exposed to light on the grass, and frequently sprinkled with water. If the material becomes dry through the absence of dew or rain, or the want of sprinkling, little or no bleaching takes place.

The one colour which Chevreul found to behave abnormally was Prussian-blue. This faded even in a vacuum; but, strange to say, on keeping the faded colour in the dark, and exposed to air, the colour was restored. It was shown that, during the exposure to light, the colour lost cyanogen, or hydrocyanic acid, while in the dark and exposed to the air, oxygen was absorbed. Chevreul concluded, therefore, that the fading of Prussian-blue was due to a process of reduction.

The prevailing opinion, however, is that the fading of colours is a process of oxidation, caused by the ozone, or hydrogen-peroxide, which is probably formed in small quantity during the evaporation of the moisture present, and both these substances are powerful bleaching agents.

It would be extremely convenient to have some rapid method of testing colours for fastness to light, and I believe it is the custom

with some to apply certain chemical tests with this object in view. The results of my own experiments in this direction, lead me to the conclusion, that at present we have no sufficient substitute for sunlight for this purpose, since I have not found any oxidising or reducing substance which affects dyed colours in all respects like the natural colour-fading agencies; further, I am inclined to the opinion that the action of light varies somewhat with the different colouring matters, according to their chemical constitution and the fibre upon which they are applied.

With respect to this last point, Chevreul actually found that colours are faster to light on some fibres than on others, and this fact, which is generally known to practical men, is abundantly shown in the diagrams on the wall. As a rule we may say that colours are most fugitive on cotton, and most permanent on wool, those on silk holding an intermediate position. Still there are many exceptions to this order, especially as between silk and wool.

Since the time of Chevreul, the action of light on dyed colours has not been seriously and exhaustively studied. From time to time, series of patterns dyed with our modern colours have been exposed to light, *e.g.*, by Dépierre and Clouet, Joffre, Müller, Kallab, Schmidt, and others; but the published results must at best be considered as more or less fragmentary. Under the auspices of the British Association, and a committee appointed at its last meeting in Leeds, I hope to have the pleasure during the next few years of studying this interesting subject.

To-night I propose to give you some of the prominent results already obtained in past years, in the dyeing department of the Yorkshire College, where it has been our custom to expose to light and other influences the patterns dyed by our students. Further, I wish to give you an ocular demonstration of the action of light on dyed colours, by means of these silk, wool, and cotton patterns, portions of which have been exposed for 34 days and nights on the sea coast near Bombay, during the month of February of this year.

I may remark that this test has been a very trying one, for I estimate that it is equal to more than a year's exposure in this country. During the whole period there was cloudless sunshine, without any rain, and each evening heavy dew. I have pleasure in acknowledging the services of Mr. W. Reid, a former student, who superintended the exposure of the patterns,

and from time to time took notes of the rate at which individual patterns faded.

These diagrams contain, perhaps, the most complete series of both old and new dyes, on the three fibres, which have been simultaneously exposed to sunlight, and they form an instructive object lesson.

Let me first direct your attention to the diagram containing the *Natural Colouring Matters*—those dye-stuffs which were in use previous to 1856. Broadly speaking, they are of two kinds: those which dye textile materials “direct,” and those which give no useful colour without the aid of certain metallic salts, called “mordants.”

Now, among the natural colouring matters, these “mordant-dyes,” as they may be conveniently termed, are much more numerous than the “direct-dyes;” but, be it observed, we have fast and fugitive colours in both classes.

Referring first to the wool patterns and to the “direct-dyes,” we find that the only really fast colours are Prussian-blue and Vat indigo-blue. Turmeric, orchil, catechu, and indigo-carmine are all extremely fugitive.

As to the “mordant-dyes,” some yield fast colours with all the usual mordants, *e.g.*, madder, cochineal, lac-dye, kermes, *viz.*, reds with tin and aluminium, claret-browns with copper and chromium, and dull violets with iron.

Other dyestuffs, like camwood, brazilwood, and their allies, also young fustic, give always fugitive colours whatever mordant be employed; others again, *e.g.*, weld, old-fustic, quercitron-bark, flavin, and Persian-berries give fast colours with some mordants and fugitive colours with others; compare, for example, the fast olives of the chromium, copper, and iron mordants, with the fugitive yellows given by aluminium and tin. A still more striking case is presented by logwood, which gives a fast greenish-black with copper and very fugitive colours with aluminium and tin. Other experiments have shown that the chromium and iron logwood-blacks hold an intermediate position. Abnormal properties are found to be exhibited by camwood and its allies, with aluminium and tin, the colours at first becoming darker, and only afterwards fading in the normal manner.

When we examine the silk patterns, we find, generally speaking, a similar degree of fastness amongst the various natural dyes, as with wool; in some instances the colours appear even faster, notice, for example, the catechubrown and the colours given by brazilwood and its allies, with iron mordant.

On examining the cotton patterns, we are at once struck with the marked fugitive character of nearly all the natural dyes. The exceptions are:—the madder colours, especially when fixed on oil-prepared cotton, as in Turkey red; the black produced by logwood, tannin, and iron; and a few mineral colours, *e.g.*, iron-buff, manganese-brown, chromate of lead orange, &c., and Prussian-blue. Cochineal and its allies, which are such excellent dyes for wool and silk, give only fugitive colours on cotton.

The main point which arrests our attention in connection with the natural dyes seems to me to be the comparatively limited number of fast colours. Very remarkable is the total absence of any really fast yellow vegetable dye, and it is probably on this account that gold thread was formerly so much introduced into textile fabrics. Notice further the decided fastness of Prussian blue, especially on wool and silk; while we cannot but remark the comparatively fugitive character of vat indigo-blue on cotton, and even on silk, compared with the fastness of the same colour when fixed on wool.

Now, let us turn our attention to the *Artificial Colouring Matters*, derived with few exceptions from coal-tar products.

Here again we have two classes, "mordant-dyes" and "direct-dyes." Both classes are somewhat numerous, but whereas the former may be conveniently shown on a single diagram sheet, it requires a considerable number to display the latter.

First let us examine the wool patterns dyed with the "mordant-dyes."

We find there a few yellow dyes quite equal in fastness to those of natural origin, or even somewhat surpassing them, *e.g.*, two of the alizarin yellows, *viz.*, those marked R and G G W. Except in point of fastness and mode of application, I may say that these are not true alizarin colours, neither are they analogous to the natural yellow dyestuffs, for they are incapable of giving dark olives with iron mordants. Truer representatives of the natural yellow dyes appear, however, to exist in galloflavin and the alizarin yellows marked A and C, and, as you see, they are of about the same degree of fastness.

Among the red dyes we have alizarin and its numerous allies, and these are certainly fit representatives of the madder-root, which indeed they have almost entirely displaced. The most recent additions to this important class are the various Alizarin Bordeaux. The only dyes in this group which appear somewhat

behind the rest in point of fastness are purpurin and alizarin-maroon.

On this same diagram we notice, also, fast blues and dark-greens, of which we have no similar representatives among the natural colouring matters. I refer to alizarin-blue, alizarin-cyanin, alizarin-indigo, alizarin-green, and cœrulín.

Further, an excellent group of colouring matters, giving fast browns and greens with copper and iron mordants respectively, is formed by naphthol-green, resocinol-green, gambin and dioxin.

The only fugitive dyes of the class now under consideration are some of the yellows, gallamin-blue, and gallocyanin.

If we now turn to examine the colours given by these artificial "mordant-dyes" on silk, we notice, also, a good series of fast colours similar to those which they give on wool; and even on cotton we see many fast colours, of which we have no representatives among the dyewoods.

If we were not prepared to find so few really fast natural dyes, surely we cannot but be surprised to find what a considerable number of fast dyes are to be met with among the coal-tar colouring matters requiring the aid of mordants.

On these diagrams, the first vertical column shows the stain given by the colouring matter alone; the remaining columns show the colours obtained when the same colouring matters are applied in conjunction with the several mordants—chromium, aluminium, tin, copper, and iron.

It was formerly held that the office of a mordant was merely to fix the colouring matter upon the fibre; we now know, however, and it is plainly illustrated by these diagrams, that this view is erroneous, for the mordant not only fixes but also develops the colour; the mordant and colouring matter chemically combine with each other, and the resultant compound represents the really useful pigment or dye. If a colouring matter is combined with different mordants, the dyes thus obtained represent distinct chemical products, and it is quite natural, therefore, to find them differing from each other in colour, and their resistance towards light.

Knowing this, it is clearly the duty of the dyer to apply each colouring matter of this class with a variety of mordants, and to select the particular combination which gives him the desired colour and fastness. By adopting this method, however, his selection would ultimately comprise a large number of colouring

matters paired with a great variety of mordants. In order, therefore, to avoid the intricacy involved in the use of several mordants, and to simplify the process of dyeing, especially when dyeing compound shades, the dyer prefers to limit himself as far as possible to the use of a single mordant, and to employ along with it a mixture of several colouring matters.

Now the woollen dyer has largely adopted an excellent mordant in bichromate of potash; it is cheap, easily applied, and not perceptibly injurious to the fibre. It is his desire, therefore, to have a good range of red, yellow, blue, and other colouring matters, all giving fast dyes with this mordant. This action and desire on the part of the dyer, has more and more placed the problem of producing fast colours upon the shoulders of the colour manufacturer or chemist, and right well has the demand been met, for in the diagram on the wall we see how, in the alizarin colours and their allies, he has already furnished the dyer with a goodly number of dyestuffs, yielding fast dyes with this chosen mordant of the woollen dyer. Since, however, they yield fast colours with other useful mordants, and upon other fibres than wool, these alizarin colours prove of the greatest value to the dyer of textile fabrics generally. Let us not forget the fact, then, that it is among the "mordant-dyes" the very class to which belong most of the natural colouring matters, that we find our fastest coal-tar dyes.

When we examine the results of actual exposure experiments, such as are here shown on these four diagram sheets, surely we have no hesitation in declaring how utterly false is the popular opinion that all coal-tar colours are fugitive to light, while the good old-fashioned natural dyes are all fast. The very opposite indeed is here shown to be the case. For myself, I feel persuaded that at the present time the dyer has at his command a greater number of fast dyes derived from coal-tar than from any other source, and I believe it possible to produce with dyes obtained from this source alone, if need be, tapestries, rugs, carpets, and other textile fabrics, which shall vie successfully, in point of colour and durability of colour, with the best productions of the East, either of this or any other age.

How, then, does it happen that these coal-tar colours have been so long and so seriously maligned by the general public? Apart from the fact that public opinion has been based upon an imperfect knowledge of the subject, we shall find a further explanation when we examine the diagrams showing the "direct-

dyes" obtained from coal-tar. According to their mode of application I have here arranged them in three large groups, viz., basic, acid, and Congo colours. A fourth group, comprising comparatively few, is made up of those colours which are directly produced upon the fibre itself.

The "basic-colours" have a well-known type in magenta. They are usually applied to wool and silk in a neutral or slightly alkaline bath; on cotton they are fixed by means of tannate of antimony or tin. The "acid-colours" are only suitable for wool and silk, to which they are applied in an acid bath. A typical representative of this group is furnished by any one of the ordinary azo-scarlets which in recent years have come into prominence as competitors of cochineal. The "Congo-colours" are comparatively new, and are conveniently so named from the first colouring matter of the group which was discovered, viz., Congo-red. They are applicable to wool, silk, and cotton, usually in a neutral or slightly alkaline bath. Of the dyes produced directly upon the fibre itself, one may take aniline-black and also Primulin as a type, the latter a dye somewhat recently introduced by Mr. A. G. Green, of this city.

Our first impression, in looking at these "direct-dyes," is that they are more numerous and more brilliant than the "mordant-dyes," and that they are for the most part fugitive. Still, if we examine the different series in detail, we shall find here and there, on the different fibres, colours quite equal in fastness to any of the "mordant-dyes."

Among the "basic-colours" we search in vain, however, for a really fast dye on any fibre. Still Magdala-red, perhaps, appears faster than the rest on silk, and among the greens and blues we find a few dull blues on cotton, which, for this fibre, have been recommended as substitutes for indigo, viz., Indophenin-paraphenylene, blue, cinerein, Meldola's blue, &c. The azine-greens also, appear tolerably fast on cotton and on silk, but although possessing some body of colour, after exposure, the original dark green has changed to a decided drab.

When we examine the "acid-colours," however, we meet with a number of scarlets, crimsons, and clarets, possessing considerable fastness, both on wool and on silk. Some, indeed, appear almost, if not entirely, as fast as cochineal scarlet, *e.g.*, Biebrich-scarlet, brilliant-crocein, &c., &c.

Among the "acid oranges and yellows," we also find a goodly number which are of medium

fastness. About ten, either on wool or on silk, may even be accounted really fast, and are fit, apparently, to rank with the alizarin colours. Note, for example, on wool: crocein-orange, aurantia, orange-crystal, Tartrazin, milling-yellow, palatine-orange; on silk, acid-yellow D, brilliant-yellow, azo-acid-yellow, metanil-yellow, curcumin S, &c. I may remark that these are some of the fastest yellows on wool and silk with which we are acquainted. It is interesting to note the decided fugitive character, on silk, of tartrazin, aurantia, orange-crystal, &c., compared with their great fastness on wool. Observe, also, how, on wool, the pale lemon-yellow of picric acid has changed to a full reddish-brown.

Among the "acid greens and blues," all the colours are fugitive, both on wool and on silk. Patent-blue appears slightly better than the rest. Of the "acid blacks and violets," a few colours are of medium fastness, both on wool and silk, *e.g.*, naphthol-black, naphthylamine, black, resorcinol-brown, fast-brown, &c.

When we examine the Congo-colours, amid a number of very fugitive colours, we find a few which are satisfactorily fast. Among the reds, for example, diamine-fast-red is quite remarkable for its fastness, both on wool and silk, and may certainly rank with alizarin; but, on cotton, it is quite as fugitive as the rest. Of medium fastness on wool, are Brilliant Congo G and R, Congo G R; and on silk, diamine-scarlet B, deltapurpurin 5 B, and Brilliant Congo R.

Among the "Congo oranges and yellows," we find some of the fastest on cotton of this class of colours; still they deserve only the rank of medium fastness. They are, Mikado-orange 4 R, R, G. Hessian yellow, curcumin S, chrysopinin. On wool, we have about half a dozen of medium fastness, *viz.*, benzo-orange, Congo-orange R, chrysophenin G, chrysamin R, brilliant yellow. On silk, however, we find in this group about a dozen of the fastest oranges and yellows with which we are acquainted for this fibre, *viz.*, Congo-orange R, Chrysophenin G, diamine-yellow N, brilliant-yellow, curcumin W, benzo-orange, Hessian-yellow, chrysamin R and G, cresotin-yellow R and G, cotton-yellow G, and carbazol-yellow.

Does it not appear somewhat remarkable that we should find among this generally fugitive group of colouring matters colours which are so eminently fast on silk, and which we entirely fail to meet with among those groups which usually furnish our fast colours, *e.g.*, the alizarin group.

Passing on to the "Congo violets, blues, and purples," we find few colours worthy of particular notice for fastness. Diamine-violet N appears, perhaps, of medium fastness on wool and silk, while sulphonazurin, benzo-black-blue, and direct-grey may claim the same distinction on silk.

In the small group of colours which are produced directly upon the fibre, none seem to call for special notice, except aniline-black, which, notwithstanding its direct derivation from aniline, is probably the fastest colour we have upon any fibre.

Now, in classifying the whole range of coal-tar colouring matters into "mordant-dyes" and "direct-dyes," and the latter into acid, basic, Congo colours, &c., I have looked at them from the point of view of the dyer, and arranged them according to colour and mode of application. The chemist, however, classifies them quite differently, *viz.*, according to their chemical constitution, *i.e.*, the arrangement of the atoms of which they are composed, and thus we have nitro-colours, phthaleins, azines, and so on.

In studying the action of light on the coal-tar colours from this point of view, we find that, whereas the members of some groups are for the most part fugitive, the members of other groups are nearly all fast, and it becomes at once apparent that the chemical constitution of a colouring matter exercises a profound influence upon its behaviour towards light. Members of the rosaniline group are all similarly fugitive, while those of the alizarin group possess generally the quality of fastness. Particularly fugitive are the eosins, and yet some of these, by a slight modification of constitution, *e.g.*, the introduction of an ethyl group, as in ethyl-eosin, are rendered distinctly faster.

In the azo group some colours are fugitive, others are moderately fast, and it is generally recognised that certain classes of the tetrazo-compounds are distinctly faster than the ordinary diazo-colours.

By a careful study of the influence of the atomic arrangement upon the stability of colours, information useful to the colour manufacturer may possibly be gained, but at present my facts are not yet sufficiently tabulated to enable one to recognise any generally pervading law in this direction.

It is scarcely necessary to say that the fastness to light of a colour is independent of its commercial value, this being mainly determined by the price of the raw material from

which it is manufactured, the working expenses, and the profit desired by the manufacturer. Neither must we suppose that facility of application necessarily interferes with its fastness to light, for some of our fastest coal-tar colours on wool, *e.g.*, diamine-fast-red, tartrazin, &c., are applied in the simplest possible manner. On the other hand, the intensity or depth of a colour has considerable influence on its fastness. Dark full shades invariably appear faster than pale ones produced from the same colouring matter, simply because of the larger body of pigment present. A pale shade of even a very fast colour like indigo will fade with comparative rapidity. The fugitive character of many of the coal-tar colours is, in my opinion, rendered more marked, because, owing to their intense colouring power, there is often such an infinitesimal amount of colouring matter on the dyed fibre. Hence it is that in the Gobelin tapestries pale shades on wool are frequently obtained by the use of more or less unchangeable metallic oxides and other mineral colours, to the exclusion of even fast vegetable dyes.

It is interesting to examine what is the action of light upon compound colours. Is a fugitive colour rendered faster by being applied along with a fast colour?

My own opinion, based upon general observation, is that it is not, and that when light acts upon a compound colour the unstable colour fades, while the stable colour remains behind. A woaded colour, for example, is only fast in respect of the vat-indigo which it contains, and yet how frequent is the custom to unite with the indigo such dyes as barwood, orchil, and indigo-carmine, the fugitive character of which I have pointed out.

Having thus rapidly surveyed these numerous coal-tar colours, both in their dyed and exposed conditions, I again ask why are they so generally regarded as altogether fugitive?

First, because we have, especially among these "direct-dyes," a very large number which are undoubtedly very fugitive.

Moreover, all the earlier coal-tar dyes—mauve, magenta, Nicholson-blue, &c., belonged to a class which, even up to the present time, has only furnished us with fugitive colours. They were indeed prepared from aniline, and it appears to me that the defects of these early aniline colours, as well as their designation, have been handed down to their successors without due discrimination, so that in the popular mind the term "aniline colour" has become, as a matter of habit, synonymous with

"fugitive colour." But science is progressive, fields of investigation other than aniline have been opened up, so that now, although a large number of fugitive dyes are still manufactured from coal-tar, there are others, as we have seen, which are as fast and permanent as we have ever had from natural sources.

Finally, and perhaps this is the most important cause of all, many of the fugitive coal-tar colours are gifted, I will not say with fatal beauty, but with a facility of application, and such comparative cheapness in consequence of their intense colouring power, that the dyer, tempted by competition, applies them not unfrequently to materials for which, because of their ultimate uses, they are altogether unsuited; and so it comes about that we find the most fugitive colours applied indiscriminately and without due discretion.

As we look upon these multitudinous colours, one other thought cannot fail to cross our minds. Is there not surely an overproduction of these fugitive coal-tar colours? Is not the dyer bewildered with an *embarras de richesses*, so that he knows not where to choose?

There is indeed much truth in this. With rare skill and ingenuity an army of chemists is busy elaborating these wonderful dyes; but in such quick succession are they introduced into the dye-house that the busy dyer has no time sufficiently to prove them, and it is not surprising therefore that he is liable to commit errors in their application.

But if there is an over-production of fugitive colours, there is also at work, as in the organic world around us, the counteracting influence of the law of the survival of the fittest. Sooner or later, the fugitive colours must give way to those which are more permanent, and already the number of coal-tar colours which have been discarded, for one reason or another, is considerable.

Not unfrequently one is asked the question, is there no method whereby these fugitive colours can be made fast? Knowing the efficacy of mordants with certain colouring matters, is there no mordant which we can generally apply with this desirable object in view? The discovery of such a universal mordant I believe to be somewhat chimerical, and yet, curiously enough, a number of experiments have been recorded in recent years, which almost seem to point in the direction of selecting for such a purpose ordinary sulphate of copper.

Some of these diagrams before you this evening show clearly the fastness to light

generally of the lakes formed with copper mordant. This peculiarity of the copper compounds has not escaped the notice of other observers. Dr. Schunck, for example, during the progress of his research on chlorophyll, noticed the very permanent green dye which this otherwise fugitive colouring matter gives in combination with copper.

Then there is the assertion of practical dyers, that the use of copper sulphate in dyeing catechu - brown on cotton, assists materially in rendering this colour fast to light.

The use of copper mordant with phenolic colouring matters is perfectly natural. Some time ago, however, it was successfully applied, for the purpose of rendering more permanent, to certain of the Congo-colours on cotton, *e.g.*, Benzo-azarine, &c., in the application of which, metallic salts had not hitherto been deemed necessary.

Noelting and Herzberg have also observed that the fastness to light, even of basic-colours *e.g.*, magenta, methyl-violet, malachite-green, &c., is increased by a subsequent treatment of the dyed fabric with copper sulphate solution, although in many cases the colour is much soiled thereby.

Still more recently, A. Scheurer records that by impregnating or padding certain dyed fabrics with an ammoniacal solution of copper sulphate, the colours gain considerably in fastness to light. As the result of his experiments Scheurer concludes that this protective influence of copper on dyed colours is a general fact, apparently applicable to all colours; that it is not necessarily due to its action as a lake-forming substance, since intimate union between the colouring matter and the copper salt is not necessary. He seems rather inclined to ascribe its efficacy to the light being deprived of its active rays during its passage through the oxide of copper.

Knowing, however, the strong reducing action of light in many cases, and with the absence of positive knowledge concerning the cause of the fading of colours, it seems to me that the beneficial influence of the copper may just as probably be due to its well-known oxidising power, which counteracts the reducing action of the light.

It is interesting to note, in connection with Scheurer's view, that, many years ago, Gladstone and Wilson (1860) proposed to impregnate coloured materials with some colourless fluorescent substance, *e.g.*, sulphate of quinine, evidently with the idea of filtering-off the active ultra-violet rays. How far some

such method as this might prove successful I cannot say, but since we cannot keep our dyed textile materials in a vacuum, as Chevreul did, nor is it desirable to impregnate them with mastic varnish for the purpose of excluding air and moisture, as Mr. Laurie proposes, in order to preserve the colours of oil paintings, it is perhaps well to bear in mind the principle here alluded to as a possible solution of the difficulty.

I have dwelt rather long on this important question of the action of light on dyed colours, but I have done so because I thought it would most interest you. With the remaining portions of my subject I must be more brief.

THE ACTION OF MILLING ON COLOURS.

Next, if not equal, in importance to the action of light, is the consideration of the effect on dyed colours, of those manufacturing operations to which the dyed materials must of of necessity be submitted.

These vary considerably according to the material, and without enumerating them, I propose first to direct your attention to that of "milling" or "fulling."

When a piece of woollen cloth leaves the loom, it has not, unfrequently, a coarse, sack-like appearance; quite intentionally, in order to obtain a certain quality of texture, the warp and weft threads have not been brought into closest contact with each other in the loom. This is only effected subsequently by the milling operation, which consists in squeezing and hammering the cloth, previously moistened with a little strong soap solution, in special forms of apparatus. During this operation, the threads and fibres are felted together, and the fabric gradually becomes more and more compact.

What, then, are the influences thus brought to bear upon the colours of the fabric, supposing these to have been previously imparted to the wool or yarn of which it is made?

First, there is the action of the slightly alkaline soap; the colours should not be dissolved-off by it, nor destroyed, nor even materially impoverished or altered in hue.

Further, if the fabric is composed of variously coloured yarns, as, for example, in tweeds, the colours must not "run" or "bleed," *i.e.*, the colouring matters of one set of threads, if at all removed, must not stain those of another set; white threads particularly must maintain their pristine purity, otherwise the pattern loses sharpness and decision, or the whole fabric appears soiled, and is thereby rendered quite unsaleable. This

difference in effect obtained by employing colours fast or fugitive to milling, is well shown in the stripe and check patterns woven in our Yorkshire Textile Department, by my colleague, Prof. Beaumont.

The action of milling on dyed colours may be rapidly determined in the laboratory, by vigorously rubbing together, with strong soap solution, the dyed pattern and some white flannel. It is better still to stitch soft white woollen yarn into the dyed pattern, and then to submit it to the actual milling operation of the factory, along with a large piece of white cloth.

On these two diagrams are patterns which have been milled in this manner; and on close examination they show how very differently the various classes of colouring matters behave when submitted to this operation. Fast to milling, especially with respect to bleeding, are all those phenolic colouring matters which can only be applied by means of mordants, *e.g.*, alizarin, cœrulein, fustic, logwood, &c. Why do these colours not bleed? Because in the dyed fibres the colouring matters form, in combination with the mordant, an insoluble precipitate, which is largely enclosed within the substance of the fibre. That portion of the precipitate which lies on the surface is undoubtedly removed mechanically during the milling process; but even then, since the colouring matter is combined with the mordant, and is not in the free state, it cannot combine with the mordants of neighbouring dyed fibres, nor can it be attracted by and stain, unmordanted white fibres.

I would, however, specially draw your attention to the fact, that even this class of "mordant-dye," as I have termed them, are liable to bleed in milling, if they are improperly applied.

Allow me to reiterate that, in the case before us, the development of colour during the dyeing process is due to a chemical combination taking place between the colouring principle of the dyestuff and the mordant. This being so, the coloured pigment, lake, or precipitate, produced, has a fixed chemical composition—a definite amount of colouring matter has combined with a definite amount of mordant.

It does happen, however, that the normal pigment at first produced within the fibre is capable of taking up in the dye-bath a further amount of colouring matter, if the latter is employed in excess; the normal compound is, as it were, changed into a more acid compound.

Further, the wool fibre itself absorbs a certain small amount of colouring matter, which re-

mains uncombined with the mordant. If, therefore, a deficiency of mordant or an excess of colouring matter has been employed in dyeing, the uncombined or loosely combined colouring matter will assuredly be removed during the milling process, and give rise to "bleeding."

How necessary it is then, with dyes of this class, that mordant and colouring matter should be duly proportioned to each other, and yet how prevalent is the custom among dyers to mordant with a fixed amount of mordant, and to dye with the most varied amounts of colouring matter.

The practical dyer is apt to reply: "Ah! we are far from dyeing according to molecular weights yet." Quite true, and yet I would venture to say, in the language of Sir Frederick Bramwell, that these are some of the "next-to-nothings" attention to which will certainly distinguish the dyer of the future from the "rule-of-thumb" dyer of the past. Nay, even at the present time, the intelligent dyer cannot afford to ignore these little matters, or he will, ere long, find himself left behind in the race. But to return, so far as fastness to milling is concerned, it is better even to employ a slight excess of mordant than a deficiency, but of course it is best to determine by experiment, and to employ, exactly that proportion of mordant which is best suited to each per-centage of colouring matter employed.

In all cases it is advisable to fix, by what is known as the "saddening method," *i.e.*, by the application *after* the dyeing process, of a small amount of mordant, that remnant of colouring matter which the wool itself has absorbed.

Now let us pass on to the consideration of those colouring matters which dye wool *direct*, *i.e.*, without the aid of a mordant. How do these behave towards the milling process?

In many cases they are not fast. Since they dye without mordant, the little colouring matter, which invariably comes off during milling, readily dyes the whole fabric, staining the whites and soiling, more or less, all the pale shades of contiguous fibres.

Colouring matters allied in chemical constitution to magenta, the azo-scarlets, nitroso-compounds, and some other basic and acid colouring matters, nearly all bleed during milling. The dyed colours themselves perhaps are not materially impoverished, so that a plain dyed fabric might be milled with impunity, provided the soap used be of good quality, *i.e.*, not too alkaline; nevertheless such colouring matters are practically useless for tweeds and the like, where variously coloured fibres are

interwoven. It is interesting to note, however, that many even of the "direct-dyes" are perfectly fast to milling.

Even among the triphenyl-methan colours, *i.e.*, those of the magenta group, there are a few specially remarkable exceptions to the rule, *e.g.*, Victoria-blue and night-blue. Members of the eosin group are also generally characterised by their fastness to milling, *e.g.*, Cyanosin, Phloxin, Rose Bengal, &c. Similarly fast is the phenolic colouring matter of orchil, and I must not forget another natural colouring matter, *viz.*, vat-indigo.

Most noteworthy for fastness to milling, is the whole group of "Congo-colours," which we saw were generally so fugitive to light. These form a special class of azo-colours, and it is in consequence of this fastness to milling, and the fact that they dye cotton *direct*, that, notwithstanding their generally fugitive character towards light, they have made such rapid progress commercially. It is well to add that this fastness to bleeding of Congo colours only refers to wool; any white cotton fibres in the fabric milled would certainly be stained.

Why do some of these direct dyes bleed and others not? One might be inclined to answer that those colouring matters which dye in an alkaline bath will probably bleed, since an alkaline condition prevails during milling. To some extent this explanation is satisfactory, witness the general instability in this respect of the basic colouring matters; on the other hand, how shall we explain the remarkable fastness of the Congo-colours which are also applicable in a slightly alkaline bath; further, how explain, in this way, the fugitive character, as regards bleeding, of all those colouring matters which are only applied in an acid bath, and which, therefore, we should materially expect to be incapable of staining when in an alkaline condition.

A possible explanation—in some cases, at least, which occurs to me is, that those colouring matters which are fast to milling form very insoluble compounds with the substance of the wool-fibre itself, which thus acts as it were as a mordant, and thus they are fixed as insoluble pigments within the fibre.

But to continue. Many "direct-dyes," more particularly those which are applied to wool in an acid bath, have the defect of being greatly impoverished in colour during milling, even to the point of total destruction apparently. Examples of this class are, acid-magenta, azo-scarlets and oranges, indigo-carmin, &c.

In the cases now referred to, the colour is partly or entirely restored, by passing the milled piece through dilute sulphuric or acetic acid. The reason of this decolourising action is very evident. The alkali of the soap has neutralised the "colour-acid" of the dyed fibre, and produced a pale coloured, or even colourless, alkali-salt of the colour-acid.

The restoration of the colour during the subsequent passage through acid is due to the decomposition of the colourless alkali-salt, with the liberation of the original highly-coloured colour-acid.

In illustration of this point, I here show you a sample of wool which has been dyed with the colouring-matter, known as alkali-blue. Here is another sample, showing its appearance after it has been submitted to the milling process. The colour has practically disappeared. As you now see, mere steeping in acid suffices to restore the colour.

Some colours, both such as are dyed directly, or even with the aid of mordants, have the defect of being entirely altered in hue during milling. Cochineal scarlets become crimson, orchil purple becomes violet, turmeric yellow becomes brown, and so on. Here, again, the alkali of the soap either dissolves or decomposes the lake, or it combines with the colouring matter to form a differently coloured compound.

Closely allied to action of milling is

THE ACTION OF SCOURING ON DYED COLOURS.

When wool has been dyed in its loose, unspun condition, it is dried, and impregnated with oil, to facilitate the carding and spinning processes. The yarn or cloth made from such dyed fibre, has therefore to be submitted to the operation of scouring, in order to remove the oil of the spinner. It consists in washing the material in a warm solution (50°—60° C.) of soap or carbonate of soda, or a mixture of the two, until the oil is entirely removed. The stronger alkali, and the higher temperature employed, cause the operation of scouring to be even still more searching on dyed colours than that of milling. Those colours which are altered in hue, decolourised, or impoverished in colour by milling, are much more altered by scouring. Some—for example, Prussian-blue—are entirely decomposed.

The high estimation in which wool-dyed cloth is so generally held is just because the dyes selected must be fast to the subsequent manufacturing operations to which I have

referred. Still it is very unwise now-a-days to depend upon such a factor as this, for, a colour may have passed untouched through these operations, and yet be very fugitive to light or other influences.

Very susceptible to the action of scouring are the sulphonic acid colours, and, indeed, for the same reasons as were explained under the head of "milling." Fast to scouring, as a rule, are the mordant dyes, the eosins, Congo colours, and some others.

The destructive action of the scouring agent depends mainly, as I have said, upon the alkali it contains, and the temperature at which it is applied; hence all coloured goods, whether in the manufactory, the public laundry, or the household, should be washed or scoured at a low temperature, and with a soap which is as neutral as possible.

Washing-soda, in all its forms and under all its varied and alluring names, should be rigorously avoided.

ACTION OF STOVING ON DYED COLOURS.

In some instances dyed colours must be fast to what is known as the operation of "stoving." Such is the case, for example, with those coloured yarns which form the striped headings of blankets, with many kinds of woollen hosiery, &c.

In goods of this kind, white and dyed fibres are interwoven or even spun together, and the materials are submitted to a final bleaching with sulphurous acid, so that the white fibres, which may have become soiled during the spinning and weaving operations, shall ultimately appear in all their original purity.

Many "acid-colours" and "mordant-dyes" withstand this stoving operation, but others are more or less altered in colour, or are entirely decolourised, either because the colouring matter is reduced, or the colour lake is decomposed by reason of the acid vapours.

Some colours are so sensitive to the influence of sulphurous acid, that they are altogether unsuitable for the air of towns, which is always more or less charged with this gas.

Such a colour, for example, is manganese-brown, the sensitiveness of which I can show you by steeping this pattern in a solution of sulphurous acid, when it is very rapidly bleached. Catechu-brown, on the other hand, which I immerse simultaneously, is fast to this influence.

I may refer here to a colour which is re-

markable for its fastness to light and most influences, *e.g.*, acids, alkalis, &c., but which, especially in the early days of its production, gave a great deal of trouble and annoyance, just because of its sensitiveness to sulphurous acid, I refer to aniline-black. Formerly, it was not unusual for large quantities of calico, printed or dyed with this colour, to become utterly unsaleable, because during storage in the town warehouses, the outer folds all changed to a dull green colour, and although washing with alkali restored the colour somewhat, still it was always liable to turn green again. Eventually the defect was overcome by submitting the black prints to a supplementary oxidising process, whereby the sensitive black was changed into a different black, far less susceptible to the reducing action of the sulphurous acid.

On one of the diagram sheets, I have affixed dyed patterns, portions of which have been submitted to the action of sulphurous acid, and you see there how some are fast and others fugitive to this influence.

ACTION OF ACIDS ON DYED COLOURS.

Fastness to acids is required from the colours on cotton yarn intended to be woven with white woollen or worsted weft, which is subsequently dyed with acid-colours.

Further, the colours of all materials intended to be worn next the skin should be fast to acid, since perspiration contains such organic acids as acetic acid, butyric acid, &c.; and although the acidity of perspiration is slight, indeed it is sometimes alkaline, still it can exercise considerable influence on dyed colours, in consequence of the additional action of friction and heat, and by its concentration upon the fibre. There are other cases in which dyed colours have to withstand acid influences, but at this late hour I will pass them by. Fast to acids are many of the "mordant-dyes," and those colours which are dyed in an acid bath, provided the acidity is not too great. Basic-colours, and most of the Congo-colours, are very sensitive to acids. The sensibility of Congo-red, for example, is already quite proverbial, so that it is even now recommended as an indicator rather than as a dye. I will show you the extreme sensibility of Congo-red, and compare it with the fastness of alizarin-red, by steeping these two patterns in dilute acid. There, you see, the Congo-red becomes blue, the alizarin-red remains unchanged.

Now let us consider briefly the question of

THE RUBBING-OFF OF DYED COLOURS.

No colour can be considered fast in its most complete sense if it has this defect, and yet, strange as it may appear, one of our fastest dyes in all other respects, is particularly unfortunate in this respect, I refer to vat-indigo-blue. Of defective coal-tar colours in this respect, I may mention malachite-green and Victoria-blue; indeed, all the basic colouring matters show the defect more or less, especially if they are heavily dyed. Acid-colours and Congo-colours as a rule are free from the defect. On the other hand, even "mordant-dyes" are liable to rub-off if they are improperly applied. The use of mordant or dye solutions, which are too sensitive, *i.e.*, which are apt to decompose and precipitate before they have properly penetrated the fibre, should be avoided. It is an axiom in dyeing, that all colouring matters and mordants should be applied in a perfectly soluble form; further, the mordant should be thoroughly fixed upon the fibre, so that it does not bleed out into the dye bath, and thus give rise to muddy dye-liquors. The immediate cause of rubbing-off is the presence of loosely-adhering insoluble pigment upon the surface of the dyed fibre.

Not unfrequently, in the case of wool, the fault is due to insufficient scouring, the employment of hard water, or from some similar cause. The fibre is permeated or coated with lime-soap, or with grease in some form or other, which either fixes the dye upon the surface, or prevents the effectual penetration of mordant or dye solution.

Under varying conditions of temperature, this grease is ever exuding, carrying with it colouring matter to the surface, where the oily mixture is ready to stain the white pocket-handkerchief (by no means a flag of truce) applied by the merchant buyer.

But apart from such general causes of rubbing-off, there are cases where the defect is intimately connected with the nature of the colouring matter itself and its mode of application. Such, indeed, is the case with vat-indigo-blue. Let me briefly explain. Commercial indigo is an insoluble blue powder, and is the veritable substance which, in a somewhat purified form, the woad-dyer aims at fixing on the fibre. In consequence of the fermentation set up in the woad-vat, and the liberation of hydrogen, this indigo-blue is changed into indigo-white, which is soluble in the lime-water of the vat.

The indigo-dyer steeps his fabric in the indigo-white solution of the vat, and, when it has absorbed a sufficient quantity, it is passed through squeezing rollers and exposed to air. Oxidation of the absorbed indigo-white at once takes place, insoluble blue is reproduced, and precipitated upon and within the fibre. That portion of the indigo which is thus regenerated within the substance of the fibre cannot be otherwise than perfectly fast to rubbing-off, but, since the squeezing process is imperfect, the fibres are covered with a comparatively large amount of superfluous vat-liquor; this, too, oxidises, so that each fibre has a quantity of indigo-blue powder loosely adhering to its surface.

It is this portion of the dye, then, which rubs off, even though the scouring of the wool may have been absolutely perfect. How to remedy this inherent defect in a suitable and satisfactory manner is a practical difficulty not as yet thoroughly overcome.

From what I have now said, you will perceive how all-important it is that every dyer should know the sensibilities of his colours towards various influences.

It is by no means sufficient that he is merely able to match readily any given shade, that is a matter of course; such facility, in my opinion, is of little use, indeed it is worse than useless, for it is positively injurious, and partakes more or less of the nature of a fraud, if the colouring matters employed are not suited to the material dyed, and its ultimate purpose. The adequate fulfilment of these conditions alone constitutes good and creditable work. If it is true that a product of art should give us a glimpse of the life and character of the artist, so should it be with dyeing; every colour with which a textile fabric is ornamented should at least reflect the honesty of purpose of the dyer.

Herein is a justification for the existence of our schools for dyeing, where our young craftsmen may be taught to "love, honour, and obey" the fundamental principles of their art, and where, by patient study and research, the numerous problems connected with the application of colouring matters may be solved, and then published, for the benefit of the whole community.

No one, certainly, wishes to buy a coat or a curtain that alters in shade in a month, or hosiery which marks-off in the course of a summer day's walk, nor is it at all necessary that such defects should ever appear.

In justice to the dyer, however, I must ex-

onerate him from the whole blame in such matters. No doubt he is sometimes insufficiently acquainted with all the properties of the dyes he employs; but his best intentions are often altogether marred or blotted out by the urgent demands of the merchant, who, in the eagerness of modern trade competition, wishes to buy and sell cheap.

Ever and anon we hear of the incomparable fastness of the colours of Indian art-fabrics, tapestries, ecclesiastical garments, &c., belonging to past ages, when, I may remark, commercial competition was unknown; and the general public is led to believe that, not only has there been no progress in dyeing for a few centuries past, but that we have even made serious retrogression in the art.

If this were true, it would be indeed a sad reflection, that, with all the advantages of modern science, we are positively in a worse condition in this matter than in the times of the alchemists.

Happily it is not true, and I trust I have been able to show you this evening that there is no need to go back to the times of our forefathers to seek instruction in dyeing, and that we have among our modern coal-tar dyes those which are as fast, and indeed in some instances faster, than any which have been employed in the past.

DISCUSSION.

Mr. T. WARDLE said he felt it his duty to come and support his friend Professor Hummel, as he held both him and his work in great esteem, and had had three sons under his teaching, though he could not agree with a great deal which he had enunciated. Any criticisms he might make would be offered in no unfriendly spirit, but in the pursuit of truth everyone must be guided by his own experience. Dyers had generally to do what other people wanted, and generally speaking that was what was cheapest, and that was really on the whole why aniline colours had been so much used, very much to the neglect of the better vegetable tinctorial products. When he was in India, he noticed in the market place at Poonah two or three thousand men with coloured turbans, about two-thirds of which had their colours very much faded, whilst the remainder looked fairly permanent. He was curious to ascertain whether the faded ones were old and the non-faded ones new, but he found that was not so, but that the faded ones had all been dyed with aniline dyes, and he then asked the Collector to take him to one of the dyers. He found it a very small concern, and as the man was using aniline dye, can dyes, as they called them there, he asked him why he used them when he could use the native dyes, which were much faster. His reply

was that he did not want to use the can dyes, because they faded, but if his customers would only give him half a rupee for dying stuff, he could not use that which cost him two rupees. It was a pity there should be any antagonism between the two kinds of dyeing, as both might be useful in their way. All along the history of French dyeing there was the *bon teint* and the *petit teint*, the one being used for colours of real artistic merit, and the other where economy was the chief thing, and permanence was not required. Notwithstanding all the researches of the chemist, the indigo industry in India was better to-day than ever, and he hoped it might long continue, for it was the best blue, and it operated with the most beautiful mordant in the world—the atmosphere. It was a wonderful dye which had stood for ages, and it ought never to be displaced. He had examined the dyes on some of the garments of the early Christian Copts, and found them admirable. When the subject of the permanence of aniline dyes was broached at the Leeds meeting of the British Association, he remembered Professor Armstrong ridiculing the idea of men like himself, Wm. Morris, and others, expressing their conviction that there were better dyes, and saying that alizarine was simply the colouring matter of the madder, obtained by synthesis, instead of from the natural plant. That was all very well from the scientific point of view, but it was not so in reality. He saw clothes being dyed near Jeypore which were more permanent than any reds he had ever saw, and more beautiful. They were dyed chiefly with munjit, and were so permanent that he had exposed them to the sun for months, and they did not change at all. He had used alizarine, a great deal of madder, and munjit, and was quite certain that alizarine, though the fastest of all the artificial dyes, was not to be compared to madder and munjit. Another quality required by dyers was tonal quality, and this was immensely superior in the vegetable dyes. He had only to look at the series of reds exhibited tonight to be quite sure one would not like to live with them, while the colouring matter of madder was the most artistic red in the world. Professor Hummel had shown a specimen of what he called Turkey red, but it was artificial Turkey red, from alizarine; it was a violent colour, which he did not call Turkey red at all. It would be very difficult for an artist to use it in a picture; and why the world went mad after the brightest reds, from magenta downwards, he never could understand, except it was from the novelty of the wonderful discovery of Dr. Perkin and his successors. All praise to them as scientific discoveries, but the subject had also to be considered from the artistic point of view. His journey to India had convinced him that there was no reason for discarding old-fashioned dyes in favour of new ones. Vegetable colours, properly applied, were not nearly so much affected by artificial light as artificial dyes were.

Many of the purples, mauves, and other colours shown on the wall were distressingly dull, and when they faded they faded badly; the old colours faded in a different way. He had a great variety of old Coptic garments, and they dated from the 3rd to the 9th century, the colours had stood beautifully. It was said at the British Association, at Leeds, that they had been buried all these centuries, and had not been exposed to the light; but they had been well worn, for many of them were darned and over-darned, and almost worn out, so that they had been well exposed to light in their time. He exposed them at the Manchester Exhibition to British sunlight for the whole summer, and did not find them change at all. Many vegetable colours, such as turmeric, were no doubt extremely fugitive; but the art of dyeing was not the science of dyeing, and he had found dyers in India who dyed fast turmeric dye. He had known many foremen who could produce permanent dyes with almost fugitive materials, by their understanding of the proper relationship between the mordant, the tinctorial matter, and the fibre with which they had to deal. In silk, he must state his conviction that none of the dyes on Mr. Hummel's fast list were really fast, excepting in extremely dark shades, for he had tried them all many times, and almost any dye would take a deal of light to exhaust all the colour from it. The fugitive character of these dyes was shown by the fact that some of the largest businesses, both in Germany and the United Kingdom, were those of re-dyers—people who re-dyed faded materials. As a chemist, he had a great respect for these discoveries, and used a great many of them, but as few as he could, and only in business which required him to use those things which were cheapest, and which his customers insisted upon having. But he had another establishment, an art dyeing and printing works, where people were bound to take what he gave them, and there he endeavoured to keep up the traditions of the past, and he was quite certain the results obtained, which were being improved year by year, were such as he would not exchange for the whole series of artificial dyes yet invented. There was a great deal of truth in the statement that the action of light depended a great deal on the chemical composition of the colouring matters, and of the fibres upon which they were applied; but he remembered his father's troubles, 40 or 50 years ago, with irregularities in dyeing, and also remembered that they came to the conclusion that the difficulty arose from not understanding the *affinities* between the dye, the mordant, and the fibre. You might dye fibres with the fastest dyes, and get fugitive results. He did not agree that the dyer of the present day had at his command a greater number of fast dyes derived from coal tar than from any other source. That was not his experience with regard to silk dyeing. For two or three months he was extremely anxious to make alizarine blue succeed, but, except in the dark colours, it was very unsatisfactory on silk. Alizarine red was

probably the fastest of all, but it did not approach the permanence of madder or mungit, or morinda, or of a mixture of the two latter. The Indian dyer got better results with these than the Europeans did; and some were so clever, that they got, as he had just said, permanent yellow with turmeric; at least, they said so. He thought aniline colours repelled an artistic feeling. They had been brought before the public in all their rigidity and crudity, and the force of novelty had often led to their acceptance.

Mr. JOHN SPILLER said one of his most pleasing recollections of the last British Association meeting was that of a visit to Professor Hummel's laboratory, when he was at Leeds; and he agreed to every word of his extremely scientific paper, notwithstanding what had been said by Mr. Wardle in favour of the old style of dyeing. It would be a grand thing if there were some ready means of ascertaining which dyes were permanent, and which were not, before they came into general use. An experiment had been shown with Nicholson's blue. The late Mr. E. C. Nicholson, a member of that Society, was the discoverer of that blue; and he exhibited a great length of woollen rep dyed with it, in the Exhibition of 1862. At the close of the Exhibition, it was distributed amongst his friends, his (Mr. Spiller's) brother being one; and he could say, from ocular demonstration, that it was used for window curtains, and, up to a very recent period, at any rate, had not faded. Of course, contact with an alkali would soon cause the blue to disappear. On looking at the specimens, he could not help thinking that one of them—the Bengal rose—was very inappropriately named, since it seemed to disappear almost entirely when exposed to a Bengal sun.

Mr. HUGH STANNUS said he only looked at the matter from the point of view of an artist, and he agreed entirely with Mr. Wardle. He used some of that gentleman's materials some years ago, and found it very satisfactory; everything he had in his room went with it, and though the colours were not so bright as some of those now shown, they were what an artist would prefer. They all knew that the important point in dealing with colours was that they should be mixed with brains. There was a celebrated picture by Titian, at Venice, in which there was a patch of red which seemed to blaze, and yet if you put a piece of sealing wax by the side of it, it looked quite a dull, brick red. It was the brains with which the colours were mixed which produced the effect. Prof. Hummel told them he had simply brought forward the facts, and had not yet discovered the underlying theory. He ventured to think that he was on the right road, for in all science they wanted first to be sure of the facts, and experiment was the source of all knowledge. He had to find what colours stood, and what did not, under various conditions; when he had done that, he could go on further, and those who lived another 20 or 30 years might be able to congratulate Pro-

fessor Hummel on being a worthy successor to Chevreul. He had referred to Titian's limited palette, but the world would not be content with such now. All honour to the chemists who supplied them with the enlarged palette. He desired to thank the chemist for his colours only as an artist; he did not see his way to use them, still, he was quite certain that Mr. Burne-Jones could. These bright colours were like a thorough-bred racehorse: they required a clever rider. He was not a good enough colourist to use these tints, but they would be added to the general stock, and in time they would be made good use of.

Mr. C. F. CROSS said he had the honour, a short time ago, of reading a paper before the Society on the photographic application of certain aniline colours, and he could now show how the matter then mentioned was connected with the theory of dyeing. It was then shown that certain basic colours, when converted into diazo-derivatives, could be entirely discharged by the action of light in a few seconds, on a bright day; and if that were done under the conditions of photographic exposure, of course the portions not exposed were not affected, and a photographic image was the result. In subsequent experiments, Mr. Green found that, if the diazo-derivatives were spread on a surface to which it had no relation but that of contact—as a plate of glass—the diazo-derivative was quite stable, and there was no discharge of colour; it was not photographically sensitive. They knew, on the other hand, that where these colours had been applied to fabrics, to the extent of 1 or 2 per cent. silk, cotton, or a gelatine film, the discharge took place immediately. Here came the connection with the present question. Dr. Witt had recently promulgated a theory of dyeing, which was doubtless known to Professor Hummel, though he had not alluded to it, according to which he regarded it as a process of solution. One ordinarily thought only of the solution of a solid in a liquid, as salt or sugar in water, but a more philosophical definition would be reciprocal penetration, and this might occur molecularly with two solids. Dr. Witt's theory was that all dyeing operations were simply cases of differential solution. You took a solution of a colouring matter in water, and placed in that a colloidal body, and the silk or wool attracted the colouring matter to itself. This theory had been tested by applying primuline to plaster of Paris, set in a mould. They then diazotized the surface, made it photographically sensitive, and got with it the same results as with a gelatine film or a cotton fabric. Consequently there was, in that case, the solution of a solid in a solid. He believed Professor Hummel was engaged on a subject which must lead him into the most abstruse problems of chemistry. The more there was discovered of the molecular relationship of the carbon chain, and the effect of the qualifying constituents, the more light would be thrown on the subject of dyeing. Professor Hummel had taken up the modest position of only dealing with empirical results, and

every one who grappled with a great subject like this, where they knew the theory must be complicated, had to be content with empirical results in the first place; but he hoped, in his eagerness to make practical progress, he would not neglect those higher philosophical views which were after all more interesting.

The CHAIRMAN in proposing a vote of thanks to Professor Hummel, said he had at any rate demonstrated the importance of technical education, and shown how it should be carried out. He hoped all who went to Leeds would go and see the excellent laboratory of Professor Hummel, where they would be convinced that he was properly illustrating the application of science to industry. He might add, in reference to Mr. Cross's observations, that he had now a research laboratory adjoining the practical one, where he had the assistance of a distinguished technologist from Switzerland, Mr. Liechti; and he could safely say that the Clothworkers' Company, under whose auspices these laboratories had been established, would spare no expense to bring this matter to a practical success.

The vote of thanks having been passed,

Professor HUMMEL, in reply, said he quite agreed with what was said by the artists from their point of view, the colours, as exhibited, were by no means artistic; but he was there to show the individual colours belonging to the palette of the dyer, not their combinations. He had it on the authority of William Morris, that the artist did not want dull colours, but bright ones, and by their proper combination he produced the full rich tones he desired. He believed the dull pictures of many artists resulted from their mixing too many colours to obtain the desired tint, the fewer colours you used to produce a given result, the brighter would that colour be. The most artistic shades of browns, drabs, and olives could be obtained from these colours which would please the most fastidious. If they were confined to the old dyes the colours of dress materials would be very dull and dingy. Again, among the artificial dyes there were many which were by no means excessively brilliant. The great bugbear was trade competition. He was glad to know that Mr. Wardle not only dyed according to other people's wishes, but was one of those whom he wished to see more of, who would not give people what they wanted only, but what they ought to have—good honest work and dyes suited for the ultimate purpose of the fabric. He did not refer to the photographic application of coal-tar colours, for want of time; and in reference to Dr. Witt's new theory of dyeing, which had been mentioned by Mr. Cross, he believed the idea had previously been hinted at by Mr. Cross himself. Some time ago that gentleman wrote a series of articles discussing various theories of dyeing, in which he referred to the apparent similarity between the existing operation of removing colouring matter from an aqueous solution by means of ether, and the operation of dyeing. Dr.

Witt seemed merely to have expanded that idea; he cited certain facts in support of it, and stated more boldly and definitely that when a woollen fabric was dyed, the wool took the place of the ether, and that in dyed wool the colouring matter abstracted from the dye-bath existed in the fibre in a state of solution. Since, however, the theory of solution was still a debateable subject, one could say that we had still no truly satisfactory system of dyeing.

Miscellaneous.

RUSSIAN FLAX CULTURE.

Flax is grown in all parts of European Russia for local consumption, but it has an importance for manufacture only in twenty-three governments, which cultivate more than 3,105,000 acres of flax, the remaining twenty-seven governments sowing less than 675,000 acres. With regard to the object for which flax is grown, European Russia can be divided, says the United States Consul at Odessa, into two regions—the northern and the southern. In the first, flax is sown chiefly to obtain the fibre, although with the fibre seed is also obtained; and in the second, nearly exclusively for the seed. The northern region of the cultivation of flax for manufacturing purposes extends from the south-eastern part of the Baltic Sea to the central part of the Ural Mountains, within which are the governments of Livonia, Kovno, Vilna, Vitebsk, Pskov, Smolensk, Iver, Yaroslav, Nijni Novgorod, Vladimir, Kostroma, Vologda, Viatka, and Perm. More flax is cultivated in the governments of Viatka and Pskov than in the others. In the first, about 251,000 acres are sown, and in the second, about 221,000. These two provinces may be considered as the centres of flax cultivation, around which the other flax-producing provinces are grouped. The yield of flax per acre in these provinces is very different, and depends on the quality of the soil in which the flax is sown. An acre of good land produces 400 pounds of fibre and from 400 to 550 pounds of seed, but an acre of poor exhausted soil will not yield more than 160 to 200 pounds of fibre and about 265 pounds of seed. The average yield for the entire region may be considered to be from 265 to 330 pounds of flax fibre and 400 pounds of flax seed per acre. The southern region of the cultivation of flax for the sake of the seed consists of the following territory and governments:—The Don Cossack territory sowing 262,000 acres; Yekaterinoslav with 251,000; Kherson, 175,000; Tawuda (Crimea), Samara, Saratov, Voronèze, Tambov, and Poltava. In the last two provinces flax is grown both for the seed and the fibre. Flax

for the seed is mostly sown either in virgin soil or in old fallow lands. The yield of seed in this region varies from 400 to 670 pounds and more per acre, and, for an average, may be estimated at about 535 pounds per acre. The total yield of flax seed for the whole of European Russia amounts to about 1,800,000,000 pounds, and it is estimated that the gain to the country from the cultivation of flax is about 23 millions sterling. About one-half of the flax fibre produced in Russia is exported abroad, only half worked, and the greater part of the fibre remaining in the Empire is worked up by the peasants in their farm-houses into thread and linen for their own use, as well as for sale. A much smaller part of the flax goes to the spinning and weaving factories, which are situated chiefly in the governments of Vladimir, Kostroma, and Yaroslav. As regards the internal, or home trade of flax, it is almost entirely in the hands of small dealers, who drive from village to village and make their purchases in small lots. The flax thus collected is then sent in considerable quantities to the towns which serve as centres to the flax trade. The *Linum usitatissimum vulgare* and *crepitans* are being cultivated in Russia in several varieties of both kinds, but the difference in these varieties is so slight and they so easily blend, that even those initiated in the trade of the article often fail, it is said, to perceive it. Both have blue blossoms, and, occasionally, white blossoms, the blue blossoms being preferred. About 21,000,000 bushels of seed are annually raised in European Russia, the quantity exported in 1890 amounting, it is estimated, to 12,000,000 bushels. Of the total export of Russian oil seeds, England receives 57 per cent., Germany about 14 per cent., Holland about 11 per cent., and Belgium about 8 per cent. The most important markets for the sale of Russian flax (fibre) are Dundee, Lille, Ghent, and Antwerp. Flax seed, as understood in Russia comprises sowing-seed and crushing-seed. The first-named is a more carefully-sorted quality, exported exclusively for sowing purposes. Crushing-seed is the surplus seed of the flax plant which is exported for making oil, &c., as there is no demand for it as sowing-seed. The seed is sown in April, May, and early in June. It is sown earlier in the south and south-east than in the centre, west, and north, but much depends upon whether the seasons are early or late. The harvest begins as early as July, and as late as the months of August and September, earlier in the south and later in the north. The number of bushels of flax seed raised per acre depends upon the object to be attained; when the seed is the object, a much less quantity is sown per acre, and when the fibre is desired, a much larger quantity is sown. In the south and east of Russia a little over half a bushel is sown, and the yield is about ten bushels. In those parts of central Russia, where the fibre is not utilised, a little over four-fifths of a bushel is sown, and the yield is about ten bushels. In western Russia and those parts of central Russia where the fibre is

utilised, one to one and a half bushels per acre are sown, and about five bushels is the yield. In northern Russia, where the fibre is the chief consideration, nearly three bushels per acre are sown, which gives about six bushels of seed, and from 300 to 600 pounds of fibre. Flax seed is usually sown by hand; and the land should be carefully prepared, and be of good quality. The ploughing should not be less than nine inches in depth, and the land should be as free as possible from weeds, and thoroughly prepared beforehand for the reception of the seed; after the sowing, the seed is covered by passing a harrow once or twice over the ground. The cultivation of flax, whether for seed or fibre, requires for its proper development a rich black loam, having a clay subsoil. Good crops, however, are grown where the subsoil is gravel or gray sand. The working up of the flax fibre is carried out by the so-called flax breaking or flax swinging, and, further, by flax-spinning and linen-weaving factories. The total number of flax-swinging factories is 59, of flax-spinning factories 20, and of linen-weaving factories 88. These factories produce annually goods valued at over 4,000,000 sterling, which are made entirely from the flax fibre. Much linen and thread is made annually by the peasantry at their homes, the value of which cannot be obtained. Linseed, to the value of over 1,000,000 sterling, is consumed annually in Russia, a very small quantity being exported. Oil-cake, the product of flax seed, is exported to the value of about £520,000 annually.

HEMP CULTIVATION IN THE PHILIPPINE ISLANDS.

Her Majesty's Consul at Manila in his last report says, that the Manila hemp plant, which is very similar to the banana or plantain, thrives best in soil composed of decayed vegetable matter, the principal districts in the Philippine Islands in which it is cultivated being reclaimed forest land. The yield is more abundant on hilly land than on low lying flat ground, and the volcanic nature of the soil of the islands seems to be particularly adapted to the growth of the plant. The production is chiefly in the southern districts, where the rainfall is greater than in the vicinity of Manila. The trees suffer severely from excessive heat and drought. The custom in the Philippines is after clearing the land thoroughly to plant small plants of about three feet high, leaving a space of from two to three yards between each, the young shoots which spring up later on around the parent stem filling up the intervening space. The ground is carefully cleaned and weeded at least twice a year. The cost of stems suitable for planting is about one shilling and sixpence a hundred at their native plantation. As a rule it takes about three years to produce a full crop, but in a favourable soil a crop of about one-third the full production would be avail-

able in about two years after planting, the second crop the following year would yield about two-thirds, and by the fourth year a full crop would be obtained. The trees are ready for cutting when the first shoots begin to be thrown out. When the trees have matured and are ready for cutting, they are cut down about a foot from the ground, and layers are stripped off the trunk. These layers are then cut into strips about three inches in width. The strips are then drawn between a blunt knife and a board, to remove the vegetable matter from the fibre, which latter is placed in the sun to dry. As soon as it is thoroughly dried, it is ready for the market. The appearance and consequent value of the fibre depends mainly upon the care bestowed in drying it, as should it be exposed to rain and not completely dried, it becomes discoloured, assumes a brownish tint, and loses its strength to a considerable extent. The outside layer produces a reddish-coloured fibre, which is quite sound, and easily distinguishable from spoiled hemp, but fetches a lower price in the market. The cost of preparing and planting a *quión* (about seven acres) and keeping it clean up to the time of the first crop, is estimated at from two to three hundred dollars, not including the first cost of the land; and afterwards an annual outlay of about sixty dollars would be required to keep the soil free from weeds, &c. The extent of land mentioned, after the plantation is three years old, would produce from sixteen to twenty bales per annum, according to the quality of the soil. Consul Gollan says that almost without exception, landowners who devote themselves to the production of hemp in the Philippine Islands are European Spaniards, or natives of those islands, and a foreigner would have considerable difficulty in establishing himself, and would meet with many obstacles before he found himself in touch with his surroundings. Foreigners can only own land in the Philippine Islands under the following conditions, which are strictly enforced:—(1) That they reside in the Philippine Islands, and are duly registered in the books of their respective consulates, and of the government. (2.) That their lands be sold, should they leave these islands and establish their domicile elsewhere. (3.) That, in the event of the death of a landed proprietor, his heirs be compelled to reside within the territory of the Philippine Islands, or sell the property. The acquisition of land by foreign companies or associations is absolutely prohibited. The cost of native labour is about 20 or 25 cents a day; but the principle upon which the hemp plantations are worked is, that the labourer gets one half of the result of his work, the other half going to the proprietor. A labourer, under pressure, can clean about 20 pounds of hemp a day; but, as a rule, the quantity cleaned by one man, working steadily day day, averages about 12 pounds. Many unsuccessful attempts have been made to improve upon the primitive knife and board, which are, up to the present, the only means used for cleaning the fibre. The

great fault of the new inventions has been the weight of the machine, and the additional liability to break the fibre. A necessary requirement for any new machine which would replace the present method is, that it should be light enough to be easily carried about by the workmen from place to place on the plantation. The exports of hemp from the Philippine Islands, in 1890, amounted to 506,155 bales, or 63,270 tons, which, at £34 10s. per ton, the average price for the year, realised about £2,150,000.

Correspondence.

ELECTRICITY IN RELATION TO THE HUMAN BODY.

Will you allow me to make a very slight correction as to a matter of fact in the very interesting paper on "Electricity in Relation to the Human Body," in the *Journal* for March, as Dr. Harries is mistaken in supposing that he was the first to discover what has been called "electric osmosis"?

If he will refer to the catalogue of the Paris Exhibition of 1889 (cl. xiv. letter E. Belgian), he will find, among the instruments exhibited by the Belgian Medical Commission, one sent by my friend, Professor d'Odiardi, through Professor Von Corput, Dean of the Medical Faculty at Brussels.

That instrument (there described as "d'Odiardi's electrode") is one of several which had long been employed by my friend for producing the very results obtained by Dr. Harries in the autumn of 1889—probably after the close of the Exhibition. A sealed letter, describing the process, was deposited with the President of the Faculty of Medicine at Brussels before the opening of the Exhibition. The instrument was also explained to the Belgian Medical Commission and to the Paris International Medical Jury, and accepted by both. Experiments had been made in Brussels even before that time. Spectral analysis was also employed for verification of the results. No experiments could be made at the Exhibition, so Professor d'Odiardi applied to Mr. Edison (with whom he had been in communication for two years) and asked him to verify his discoveries. This is proved by Mr. Edison's own testimony as given in the New York *Morning Journal* of April 26th, which appears to have "interviewed" Mr. Edison on the subject, and gives the following account of the interview:—"A visit to Mr. Edison's laboratory at Llewellyn-park, New Jersey, elicited the fact that the wizard had been in recent communication* with Professor d'Odiardi, and had aided the latter in a modest way only. Mr. Edison says that his experiments were of a purely chemical-electric character, and were not tried on diseased parts of any human body. The experiments with Professor d'Odiardi's new machines merely demonstrated that

he had devised a more effective and easier method of reaching diseased parts through electrical osmosis."

Physicians who had no opportunity of seeing the instruments exhibited in Paris may remember a pamphlet printed by Mallett and Co. (68, Wardour-street), and sent at the beginning of 1888 to the London hospitals, and to several London specialists, in which the same principle is fully described (p. 9—"Professor d'Odiardi's electric treatment for deep penetration and subcutaneous absorption of medicinal substances").

Being personally aware of the fact that Professor d'Odiardi had undoubtedly applied by means of instruments invented by himself, the law of electric osmosis for subcutaneous penetration of medicinal substances long before 1889, I feel sure you will allow me to put the facts in a proper light. Thanking you in anticipation, and with many apologies for trespassing so seriously on your time and space,

I am, &c.,

J. S. PENNINGTON,

Madras Civil Service (Retired).
23, Trebovir-road, 11 May, 1891.

PETROLEUM IN STEAM BOILERS.

In the *Journal* of 8th May, Professor Unwin gives the results of his trial of a petroleum burner in a steam boiler, and then condemns useless experiments made without exact measurements. Thus far we fully agree. However, I am of opinion that he is mistaken in supposing that the figures quoted by me for the evaporative power of petroleum refuse were obtained from such "experiments in which a boiler was worked one day with coal, and another day with oil," as in the trial referred to. The figures given by Mr. Thomas Urquhart in his paper before the Institution of Mechanical Engineers (see *Proceedings*, January, 1889) were the result of six years' actual experience with petroleum refuse in locomotives specially designed for the purpose, and as such are not to be ignored when considering the relative value of the two fuels—coal and oil—under ordinary working conditions. Professor Kennedy stated that he checked the figures in Table XVII. of this paper, and as to the practical evaporation of 14 lb. of water per lb. of petroleum refuse, realised at the effective pressure of 8½ atmospheres, "he had not the least doubt the figures had been most carefully arrived at." (See *Proceedings*, pp. 69 and 79.) Everyday experience proves that in ordinary locomotive practice on the Grazi and Tsaritsin Railway, South-east Russia, an evaporation is obtained of 12·25 lb. of water per lb. of petroleum refuse. Now, the composition of the fuel used (Table XVII.) shows that this result is *not* impossible. Again (Table XII.), the average consumption of coal in eight-wheeled coupled locomotives throughout the year 1882 was 79·08 lb. per engine-mile, as compared with the average 40·47 lb. of petroleum refuse per engine-mile during the year 1887. Also, in special trials of the eight-wheeled

* This is a mistake; it is about a year since the Professor had any communication with Mr. Edison himself.

engines made on 69 miles' length of line, "the coal-burning engine ran six double journeys, and the petroleum engine twenty-four, with the result, per ton-mile, that 45 tons of petroleum refuse were equivalent to 100 tons of anthracite, being a reduction of 55 per cent. in weight of fuel per ton-mile. These comparisons were made with the greatest care possible, with engines in first-class order," &c. (p. 40, Table XIII.).

A careful study of this paper will, I hope, convince Professor Unwin that the results are not of the kind he describes as useless and misleading.

Nor are the figures given me by Mr. James Holden, Locomotive Superintendent of the Great Eastern Railway, merely the results of "one-day" trials. He has had locomotive engines and stationary boilers specially fitted and fired with a mixture of coal-tar and green oil for several years, and, for the sake of a rough comparison, he has noted the consumption found in practice, and in similar engines using coal in the ordinary way.

Want of time prevented a thorough treatment of this part of my subject, and I was obliged to leave out the results of trials carefully made by United States engineers and others, confirming the conclusions I arrived at.

Further, Professor Unwin is well aware that the amount of evaporation should not be taken alone when considering the relative value of two fuels for common use. There are other important advantages attending the use of petroleum as fuel instead of coal in boilers, especially on board ship, which must not be overlooked. Fires are completely under control, and more perfect combustion is insured when fires are forced, without hard labour being imposed on the human beings called stokers. Firegrates do not need cleaning of clinker so often as when coal is used as in torpedo-boats. Boiler tubes do not need sweeping so often. The carrying capacity of a ship is increased, and even a large man-of-war is able to take liquid fuel on board easily and quickly at sea without loss—not always an easy task with coal. Besides, the absence of coal-dust, ashes, and cinders, would be highly appreciated both by passengers and machinery in high-speed ocean steamers and pleasure yachts.

The only difficulty is in getting an assured supply of liquid fuel at a reasonable price. I would, therefore, again point out the desirability of developing the oil supplies of this country and its possessions for the common good of the nation.

WILLIAM ROBINSON.

May 11, 1891.

MEETINGS OF THE SOCIETY.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoon, at Half-past Four o'clock:—

MAY 26.—C. S. WILKINSON, F.G.S., "The Mineral Resources of New South Wales."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 18...Antiquaries of Ireland, Tholsel, Kilkenny, 2 p.m. 1. Mr. W. F. Wakeham, "Primitive Churches in County Dublin prior to the Anglo-Norman Invasion." 2. Mr. P. M. Egan, "Notes on some Antiquities in the City of Kilkenny," to be visited after the Meeting. 3. Rev. W. Healy, "Notes on Kells."

TUESDAY, MAY 19...Royal Institution, Albemarle-street, W., 3 p.m. Mr. William Archer, "The Betterton Period of Stage History." (Lecture I.) Pathological, 20, Hanover-square, W., 8½ p.m. Annual Meeting.

WEDNESDAY, MAY 20...Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. William H. Dines, "The Vertical Circulation of the Atmosphere in relation to the formation of Storms." 2. Mr. A. W. Clayden, "Broken Spectres in a London Fog." 3. Mr. H. Coupland Taylor, "An Account of the 'Leste,' or Hot Wind of Madeira." 4. Mr. Sheldford Bidwell, "The Effect of an Electrical Discharge upon the condensation of Steam." Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. E. M. Nelson, "Illuminating Apparatus." 2. Mr. T. B. Rossiter, "A New *Cysticercus* and the *Taenia* produced from it." Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Annual Meeting.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Guild and School of Handicraft, Essex-house, Mile End-road, E., 8 p.m. Mr. G. Thompson, "The Industrial Partnership of Woodhouse Mills."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, MAY 21...Chemical, Burlington-house, W., 8 p.m. Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m., Mr. R. Phené Spiers, "The Origin of some Architectural Forms."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. C. Mackenzie, "The Orchestra Considered in Connection with the Development of the Over-ture." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Historical, 11, Chandos-street, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, MAY 22...United Service Institute, Whitehall-yard, 3 p.m. Captain Charles Johnstone, "Masts and Sails as a Means of Training."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. Prof. J. A. Ewing, "The Molecular Process in Magnetic Inductions."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Science Schools, South Kensington, S.W.

SATURDAY, MAY 23...Botanic, Inner Circle, Regent's-park, N.W., 3¼ p.m.

Royal Institution, Albemarle-street, W., 8 p.m. Mr. H. Graham Harris, "The Artificial Production of Cold."

Journal of the Society of Arts.

No. 2,009. VOL. XXXIX.

FRIDAY, MAY 22, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Conversazione is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 17th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

Further particulars as to arrangements will be announced in future numbers of the *Journal*.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 30th, 1891: The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., in the chair.

The paper read was—

THE PERIAR IRRIGATION PROJECT, MADRAS PRESIDENCY.

BY COLONEL J. O. HASTED, R.E.

Irrigation works in India are now rather a drug in the market, and the name conveys to most people the idea of a weir across a river and a network of channels to convey water to flat uninteresting rice-fields. The Periar project is, however, an irrigation work of such a

very different character from this, that some description of it may prove of interest both to engineers and to others who are interested in the development of India.

The first questions that would be asked by anyone seeing the title of this paper are—Where is the Periar? and what is the project? The Periar, or Peria aur, means in the native language "great river," not as *the* large river of India, but rather large in comparison with others in the neighbourhood, and is a river which takes its rise in the western ghauts in the tenth degree of North latitude, near the boundary between the Tinnevely district, the most southerly in India, and the Travancore State, and its course is generally north-east in the mountains, until some sixty or seventy miles below it emerges from the ghauts in Travancore and takes an almost direct course to the Indian Ocean, into which it finds its way some miles above Cochin on the west coast. The project is to construct a large dam across the river valley, so as to form a lake, from which water will be taken by means of a tunnel through the mountain-top, and dropped down the eastern face of the ghauts into the Vyravanaur, which falls into the Sooroolyaur, a tributary of the Vigay, which rivers will carry it about sixty miles to a point some twenty miles west of Madura, where it will be distributed by artificial channels over the country.

The action of the monsoons in India is well known. The south-west monsoon, leaving the east coast of Africa as a strong dry wind, picks up moisture in its passage across the Indian ocean, and arrives on the west coast with a mass of heavily laden clouds, which discharge their contents as they reach the land, until their course is arrested by the barrier of the western ghauts, here ranging up to about 8,000 feet above the sea level. The fierce south-west wind still hurries on, but all the moisture is caught by the mountains, and it blows over the parched plains of the southern districts of India beyond, as a strong hot wind.

I have often stood on the plains of Tinnevely, at some miles distance from the western ghauts, and watched the black clouds blowing up to the very verge of the mountains, and then they seem to turn to the south and work their way along the ghauts, while all the country round me was languishing under a burning sun, and almost a hurricane of dry hot wind. The milder north-east monsoon in the same way comes moisture-laden to the

east coast, and then these parched southern districts come in for their share, sometimes a scanty supply, but sometimes a more than abundant downpour, which breaches the reservoirs and river banks, and causes loss of property and even life; enough, however of moisture is left in the monsoon clouds to reach the mountains, which are the great backbone of the peninsula, and the hill tops again receive a benefit.

It thus happens that the rivers which draw their supply from the mountains so bountifully watered run perennially, and the Periar, which we are now dealing with, is one of these; on the east of the ghauts, there is one only that I know of which has water all the year round, the Tambrapurni, in Tinnevely, the others, though subject to freshes during the south-west monsoons, have too long a course though a dry and arid country to hold out, and I have noticed quite a respectable waterfall down the eastern side of the mountains disappearing in the sand of the river bed immediately below, and leaving the river 100 yards off to all appearance a dry sandy channel.

The country on either side of the ghauts varies greatly in character: Travancore is a hilly, well-wooded region, abundantly watered, with rivers always running through it; and Madura is an almost level, arid plain, wooded in parts, and broken up to some extent by low hills, but generally flat, the surface of the country being studded with artificial reservoirs, constructed by the natives before the days of British rule, simple banks of earth, thrown up across some depression of the ground, or, perhaps, nearly semicircular on the sloping surface, to store the rainfall of the north-east monsoon for a time, and enable some few acres to be cultivated with rice. When near the river, these reservoirs are frequently supplied by an artificial channel from the river, the water being turned into it, sometimes by a temporary dam, sometimes by a stone dam built across the river, the channel head being perhaps furnished with a sluice, to enable the supply to be regulated, in which case the cultivation is more certain than when rainfall only has to be depended on.

The yearly rainfall on the plains of Madura may be taken to be, in round numbers, from about 30 to 40 inches; while that at Cochin, on the west coast, is over 110 inches; and at Augustia Mullay, one of the highest peaks in the ghauts, where the Travancore Government once had an observatory, is over 190 inches. In the Periar valley, where the works

are to be constructed, it was estimated to be about 125 inches.

It will be seen from the map that the sources of the Sooroolyaur and Vigay, which drain towards the east coast, are so near the Periar river that it will be readily understood from what has been said that the poor, scorched-up district of Madura has looked with longing eyes on the superabundant liquid treasure rolling down to the sea within such a short distance of it, and that schemes for diverting parts of it to the region where it is so sorely needed have been for years talked of, and one or two of the minor tributaries of the Periar have actually been diverted to the Madura district. So long ago as 1808, Captain Caldwell, of the Madras Engineers, reported on a proposal for diverting the waters of the Periar itself into the Vigay valley; nothing came of it then, and though the subject was subsequently discussed from time to time, it was not till 1867 that it was bought forward by Major Ryves of the Madras Engineers, in a really practical form. Major Ryves's proposal was to dam the Periar by an earthen dam 162 feet in height, and to divert the water into the Vigay valley by a cutting through the watershed, the maximum depth of which would be about 52 feet. There not being at the time sufficient information to allow of an accurate estimate being framed, investigations were ordered which were carried out from 1868 to 1871, with the result that in 1872 Mr. R. Smith, a civil engineer, submitted the first complete Periar project. Mr. Smith proposed a dam, 171 feet in height, by what is called the "silting" process, that is, directing streams of water laden with clay to the site of the dam, and ponding it until all the clay is deposited, which forms an excellent water-tight dam. During the construction of the dam the water was to be diverted through a tunnel, and an escape for surplus after completion of the dam was to be cut in a saddle on one flank of the dam. The dam was to form a lake, which would contain 6,815 mills of cubic feet of water, and the water was to be led by a tunnel, 7,000 feet in length, under the watershed ridge into the Sooroolyaur valley. Regulating sluices were provided, and works for the distribution of the water in the country round Madura. This also came to nothing, the construction of the dam by the silting process being objected to, and the subject remained in abeyance till 1882, when Colonel Pennycuik, who had been engaged on the project under Major Ryves, and had studied it for years, was directed to revise the plans and

estimates. This was done within the year, and early in 1883 the project in its present form was submitted to the Government of India, and finally received the sanction of the Secretary of State, in September, 1884. The work was commenced late in 1887, and is now in progress. The Periar project consists of the following works :—

1. The construction of a dam, 155 feet high, to close the valley of the Periar, and form a reservoir, 8,000 acres in area, which will contain 13,300 millions of cubic feet of water, of which 6,815 mills are available for irrigation.

2. The construction of a tunnel, 6,650 feet long, with an area of 80 square feet through the watershed ridge between the valley of the Periar on the west, and the valley of the Vigay on the east, for the purpose of draining off the water from the reservoir, with the necessary sluices and subsidiary works for controlling the supply.

3. The works necessary for controlling the supply down the valley of the Sooroolyaur to the Vigay, and for keeping this supply separate from the natural supply of the tributary.

4. The works necessary for the regulation and distribution of the water for the irrigation of 140,000 acres of land in the Vigay valley, Before proceeding to describe the works, it is necessary, in order to realise the difficulties in the way of carrying out the works, or of making the investigations necessary to enable accurate estimates of their cost to be framed, to give some description of the locality. The nearest station on the South Indian Railway is Ammayanaikenoor, 25 miles to the north of Madura. From there all machinery and stores must be brought by road to Periacolum, at the foot of the Purney Hills, a distance of about 27 miles, and from thence by road crossing four large unbridged streams up the valleys of the Vigay and Sooroolyaur, about 50 miles to Kuruvanth at the foot of the ghaut road leading through the Periar valley into Travancore. The ghaut road leads up the face of the mountains, and is four miles long, rising 12,000 feet with a ruling gradient of 1 in 15; the width of the road is 14 feet, and it is fit for cart traffic. Crossing the gap in the watershed the Periar valley is entered, lying in the bosom of the hills; the vegetation is tropical, the bottoms and sides of the ravines being densely covered with trees and creepers, and the hill tops with a luxuriant growth of grass; the scenery is lovely, and the climate at an elevation of between 3,000 and 4,000 feet

above the sea is pleasant when it is not raining, and the only living creatures likely to be met with are wild beasts, such as elephants, bisons, and an occasional tiger. Some of these have given much trouble to those engaged on the work. I have heard of an elephant walking directly through an officer's tent in the middle of the night, setting his foot, by the way, in the middle of the bed from which the luckless officer had just bolted. And when I visited the place with the late Governor of Madras our midnight slumbers were disturbed by the trumpeting of an elephant, who declined to leave the place in spite of the bonfires kept up all night, and the shouting of the guard posted to protect us from having the shed pulled down over our ears. I remember also a native surveyor flying before "the blue-eyed bison," as he described it, and leaving his instrument to its tender mercies. These intruders will doubtless fly before the snorting of steam-engines and the throbbing of machinery, but a greater trouble is the deadly jungle fever which for about four months of the year, from March to June, renders the place uninhabitable. The situation and circumstances of the locality therefore make the construction of the works a much more serious undertaking than that of a large reservoir in the Welsh mountains.

The site which has, after much research, been selected for the dam, is very favourable, as will be seen from the section marked (D) on the wall, diagram the width of the river at this point being about 214 feet, and the extreme length of the dam at top, measured along the parapet, being 1,200 feet; the rock which forms the bed of the river, and is on the hills overlaid by a few feet of stiff yellow clay, is described as a hard syenite; it is difficult to work, but an excellent building material, and the only one, excepting timber (of no great size) and sand, procurable on the hills. The bed of the river at this point is 2,837 feet above mean sea level, and its longitudinal fall five feet a mile; the area drained by it is estimated to be 300 square miles. The section originally proposed for the dam (to which I will refer later on) is shown on drawing on the wall marked (A). The thickness originally proposed was 12 feet at top and 115½ feet at the lowest part; it is to be constructed throughout of concrete composed of 25 parts, by measure, of hydraulic lime (ground but not slaked), 30 sand, and 100 of broken stone, the front face is to be plastered with plaster composed of equal parts of lime and sand, the lime will be ground,

the stone broken, and the concrete mixed by machinery driven by a turbine, the power for working which will be obtained from the river; the concrete will be conveyed from the machines to the point where it is required for use by a wire tramway, and rammed by a machine specially invented for the purpose.

As regards the material of which the dam is to be made, I may quote from Colonel Penny-cuick's report. He says, "Most modern dams of any magnitude have been built of uncoursed rubble masonry. Concrete is nothing more than uncoursed rubble reduced to its simplest form; as regards resistance to crushing or to percolation the value of the two materials is identical, unless it be considered as a point in favour of concrete, that it must be solid, while rubble may, if the supervision be defective, contain void spaces not filled with mortar. The selection between the two depends entirely on their relative cost. In many cases—probably in the majority—the cost of preparing the stone, and of mixing and laying the concrete, exceeds that of building the rubble, the quantities of materials in both being practically identical. At the Periar, however, skilled labour is abnormally expensive, and difficult to procure in large quantities; while the facilities for the use of labour-saving machinery, which can be largely used in the manufacture of concrete, are immensely great." The lime to be used is procurable at no great distance from the foot of the ghaut road, and, by analysis, is found to be an eminently hydraulic lime, approaching the limit of an hydraulic concrete: the composition differs very slightly from that of the well known "Theil" lime, with which all the large dams in the neighbourhood of St. Etienne have been built, and which has also been used in the concrete blocks for the Suez and Port Said harbour works.

Now, as to the section of the dam. The principles on which the pressures on the rear slope are calculated are explained in a note by Colonel Pennycuick, which is too long (and indeed hardly within the scope of this paper) to reproduce. In this note he discusses the method adopted by M. Bouvier, a French engineer, of ascertaining the pressure on the material, and gives reasons for differing with him. Plan A on the wall shows in plain, black lines the section proposed by Colonel Pennycuick, and, in dotted lines, that which it should be, calculated by M. Bouvier's method. Colonel Pennycuick estimated that a limit of pressure of 18,000 lbs. on the square foot might be

adopted; and his section fulfilled the following conditions:—1. That the lines of pressure shall always fall within the middle third of the dam. 2. That the pressure on neither face shall exceed 18,000 lbs. on the square foot. With the reservoir entirely empty there will be a trifling excess of pressure on the front face; but this case will not occur in practice, as the water level will never fall below 113 feet above the river bed, and the conditions would be fulfilled even if it were 28 feet lower than this. During construction the water level will be raised to 90 or 100 feet before the upper 30 feet of the dam is built.

When the design of the dam was examined by the professional advisers of the Governments of Madras and India, it was suggested that Sir Guilford Molesworth, then consulting engineer to the Government of India, who was known to have studied the subject of masonry dams, and had published some approximate formulæ for calculating their dimensions, should be asked to discuss Colonel Pennycuick's note. A very interesting paper was written by Sir Guilford in compliance with this suggestion, from which I can only quote the following general conclusions:—"On investigating the question I find that the two methods of M. Bouvier and Major Pennycuick respectively do not differ in their results to any appreciable extent until a certain point is reached near the base of the dam. In fact, for a dam of unlimited height, the results obtained by either method are practically identical; or, as Major Pennycuick observes, so long as this point is above the foot of the front slope it matters very little, except for principle, which method is employed. Even beyond this point, in the case of the Periar dam, the results of the two methods differ to the extent of one-half per cent. of the total quantity of masonry in the dam, M. Bouvier's results being on the side of safety. If Major Pennycuick be right in his theory, his section will, according to his estimate, effect a saving of one-half per cent. in the masonry. If, on the other hand, he should be wrong, the adoption of his section will add about 25 per cent. to the maximum pressure at a very critical part of the dam; and under the conditions of uncertainty of the whole problem, I cannot recommend the Government to risk so serious an increase as 25 per cent. in the pressure for the sake of saving one-half per cent. in the quantity of masonry." The Government therefore approved of the dam being constructed in accordance with M. Bouvier's section. Subse-

quently, Colonel Pennycuick pointed out that while this section gave a somewhat greater thickness in the lower part of the dam, it also gave a somewhat less thickness from 30 to 60 feet from the bottom, and while perfectly willing to accept it where the alteration is on the safe side, he did not think it would be desirable to do so where the change is the other way. He proposed therefore to retain the original section where it is greater than that given by M. Bouvier, merely adopting the latter where it causes an increase in the thickness. The Government consented to this, and the section finally adopted is therefore shown by the outer lines on plan on the wall (A), and gives the following dimensions to the dam: thickness of the dam at bottom $129\frac{3}{4}$ feet, at top 12 feet, height 155 feet, with parapet 4 feet wide and 5 feet high.

Waste weirs, or escapes will be formed on saddles of the hills on right and left flanks of the dam, see plans on the wall (C and D). That on the right bank has solid rock at a minimum level of 154 feet above the river bed, and will be cut down for a length of 420 feet to a level of 144 feet, or 11 feet below the crest of the dam. On the left bank the solid rock is at a level of 104 feet, and the saddle will be built across with material similar to that of the main dam to a level of 144 feet. The wall thus formed will have a length on its crest of 403 feet, and a further length of 97 feet will be obtained by cutting away the rock at both ends, giving a total length of 500 feet. At a distance of 60 feet from this escape wall a second wall will be built 10 feet in height, with its crest 30 feet below that of the first wall, to form a water cushion, see plan on the wall (B). The two escapes will have an aggregate length of 920 feet. The assumed maximum water level is 155 feet, but after observations of discharges of the river for four seasons, during which time a great flood occurred, when the discharge of the river was calculated at over 500 mills of cubic feet per hour, elaborate tables were drawn up giving this result, that at a level of 153.15 feet, the discharge over the waste weir being 311 mills of cubic feet an hour, the reservoir, if there were no other means of escape for the water, would have ceased to rise. Now as the lake between 153 and 155 feet can store over 800 mills of cubic feet, and the discharge of the weirs, which together are more than four times the width of the river, will very much increase in this two feet, while the tunnel for supplying water to the Vigay will also be draining off water,

the provision for disposing of flood water seems to be ample.

For the disposal of the river water during the construction of the dam, it was first proposed to construct a tunnel, to be partly through the rock, on one side of the river, and partly under the dam, the discharge being regulated by gates, of the nature of equilibrium valves; but very strong objections were raised to any opening under the dam; and plans were then made for iron syphons, to be raised as the dam was constructed. These, however, are cumbersome; and arrangements have now been made for passing the water over the dam itself during construction.

The rock excavated in forming the waste weirs will be made use of for the concrete; but, as above stated, all the other materials required for the dam, as also the machinery, must be brought up from the low country. From the lime quarries, which are situated at a distance of three or four miles from the foot of the ghaut, the limestone was intended to be brought by a traction engine; but, later on, it was determined to use a wire tramway. From the foot of the ghaut a wire tramway will be run to the top. The length of the ghaut road is just over four miles; and the distance from top to bottom, as the crow flies, is 10,400 feet; and, as the tramway can be laid very nearly in a straight line, a length of 12,000 feet is provided, which will give a rise of, approximately, 1 in 10. The limestone and small articles of stores and machinery, weighing up to 3 cwt., will be carried by the tramway, the power being provided by a turbine, which will be required for boring the tunnel; heavier articles must be sent up the ghaut road in carts. From the top of the ghaut to the site of the dam, it was at first proposed to make a road for traction engines, and a very favourable trace was found for it, the steepest gradient being 1 in 600, and the length a little over $7\frac{1}{2}$ miles, but on commencing the works it was found that by making use of a small stream close to the top of the ghaut it would be possible to make a navigable water-course to the site of the dam, and a series of small locks were proposed, which, when the scheme was worked out, was altered to two locks and four dams, arrangements being made for transferring the material over these dams.

Residences for the staff and workpeople, and sheds for the machinery, have been provided for, and these will complete all the work to be done in the Periar valley, with the exception of the cutting leading to the tunnel through

the ridge, and the part of tunnel itself, about 350 feet, which it is convenient to bore from the upper end. The remainder of the tunnel will be bored from the lower end, which opens on the face of the hills not far from the ghaut road, and from which the water will find its way down a stream into the bed of the Vyra-
vanaur. The cutting will start in the Mulia-
panjan valley, with bed at 113 feet above Periar
bed at site of dam, or 42 feet below top of dam,
and run northward with a fall of 1 in 440, being
21 feet wide. When the depth of the cutting
(in rock) reaches 30 feet, which will be at a dis-
tance of 5,400 feet from its starting point, the
tunnel will commence, with an area of 80
square feet and fall of 1 in 75. At the
lower end of the tunnel there will be a
cutting of 160 feet in length to bring the
water out to the stream on the ghaut. In
boring the tunnel a heading of 42 square feet
will be first driven, and this will be enlarged to
the full area, the estimate allowing for 84
square feet to provide for irregularities in the
excavations. The boring for this heading will
be done by drills driven by compressed air, the
power being obtained from a turbine, which
also will work the wire tramway up the ghaut.
About 40 horse-power for 14 hours will be
wanted for working the compressors, and 25
horse-power for 10 hours for driving the wire
tramway, and as a head of 60 feet can easily be
obtained, the quantity of water required, 8
cubic feet per second, will generally be avail-
able, but should it fail in dry seasons, arrange-
ments will be made for providing steam power
to take its place.

From the mouth of the tunnel the Periar
water will pass by the Vyra-
vanaur into the Sooroolyaur, being about 46 miles, and thence
40 miles until the main supply is taken off.
Across these rivers there are already existing
several dams, which divert the water to chan-
nels which supply the old reservoirs above re-
ferred to. It is proposed to pass the Periar
water round one of the flanks of these dams by
large sluices. At the point where the main
supply channel is taken off the Vigay there is
an existing dam called the Peranny (or great
dam) with a channel taken off. This channel
will be furnished with a head sluice of 20 vents,
all of 5½ feet span, and will be enlarged so as
to carry the Periar water, in addition to the
existing supply, for a distance of 1,460 feet,
when the main Periar channel will take off with
regulating sluices; the channel itself is de-
signed to carry 1,500 cubic feet per second
with a depth of six feet. Beyond this it

is unnecessary to describe the works,
even if time would permit me to do so,
as they are of the usual character of works of
this nature in all the large delta irrigation
works. But I may state that the irrigation
will not be solely by means of channels, as,
where the existing reservoirs are of sufficient
capacity to be of use, they will be maintained,
and supplied with Periar water, only those
which are so much silted up as to be of little
use being abandoned, and the beds cultivated.
From calculations on the observations made
during four seasons at the Periar, the estimated
discharge of the river—varying from 6,000 mills
of cubic feet in the month of heaviest rainfall,
to 800 mills in the driest month—amounts to
32,900 mills of cubic feet in the year. Of this,
1,740 mills are allowed for loss by evaporation,
and 1,490 mills for loss in the beds of the
Sooroolyaur and Vigay, of which last it is sup-
posed 500 mills may be required to fill the beds
after the dry weather, leaving 29,670 mills
available for irrigation, which is an ample
supply for the irrigation of 150,000 acres, with-
out taking into account the rainfall on the
tract to be irrigated. The extent of land com-
manded by the channels is about 200,000 acres,
of which it is proposed to irrigate a first
crop of 101,000 acres, and a second crop of
35,343 acres.

The estimate originally submitted was in
abstract, as follows, taking 10 rupees as = £1,
an old and, unhappily, now an obsolete equa-
tion, which requires at the present time a co-
efficient of about .75 to be applied to the
sterling side, and which I will apply only to
the totals:—

Works in the Periar valley	£275,000
Works in the Sooroolyaur valley . . .	33,000
Main canals and branches	136,700
Distributaries	75,300
<hr/>	
Total for works	£520,000
Charge for establishment	92,500
Tools and plant	6,000
<hr/>	
Total	£618,500

or at 1s. 6d. a rupee, £463,875. Of the
£618,500, preliminary expenses are answer-
able for £11,300, the main dam with escapes
£117,500, the tunnel and cutting £43,200,
and the compensation to the Travancore
Government £80,000. The land to be pur-
chased is the water spread of the reservoir
with site for buildings, &c. The water is
absolutely valueless to Travancore, and the

tract of jungle we require, a mere speck in the thousands of acres of forest appertaining to the native State, is almost valueless, but native States have to be tenderly dealt with, and the negotiations with respect to this subject occupied many months, and in the end instead of making a money payment down, it was agreed to lease the land required with right to divert the water for a period of 999 years at a rent of £4,000 a year, commencing from the date on which water in the Periar may by means of the project works be diverted from Travancore to British territory. It is a heavy charge against the works, and the necessity for it seems the more incomprehensible, because as I was assured by the late Sir Richard Levinge, who was for years collector in the southern districts, this land which we now require was at one time actually the property of the British Government, and when the boundaries of the Travancore State were being demarcated, it was given to Travancore; but, as I said before, the native States have to be tenderly dealt with. The effect of a yearly payment instead of a lump sum caused an alteration in the estimate, and as originally the cost of machinery was included under the head of works, a revision was necessary, and the estimate now stands as follows:—

Works	£406,933
Establishment charges....	90,567
Tools and plant	45,000
	<hr/> £542,500

or, at rs. 6d. per rupee, £406,875.

The time in which it was expected the work would be completed was six years, but this it is proposed to extend to eight years.

The question of the revenue to be expected from irrigation is rather a complicated one, as, of the land to be irrigated, part is Government land, already irrigated, part Government dry land, to be converted into wet, part of it unoccupied land, to be brought under irrigation, and part of it Zemindari and Inam land. It was, of course, worried out by the revenue officers, and, I understand, is still being worried. The result on the original estimate was an anticipated return of about 7·8 per cent. on the capital outlay, including indirect charges, and, after revision, 8·53 per cent. These figures cannot, of course, be accurate, as, until the water is brought to the land, it is impossible to say, precisely, what will be irrigated; but the country irrigable is pining for irrigation: the cultivators want the water, and it will, no doubt, be taken readily. Sir Charles

Elliot, then Public Works Minister to the Government of India, writing on the subject so late as the end of 1889, after visiting the works, says, "Taking the gross receipts at 6½ lakhs, and the working expenses at 1½ lakhs, the net profits are estimated at 5 lakhs, which, if realised, will give a very handsome return on the capital outlay."

In August, 1887, arrangements were made for commencing the works, Colonel Pennycuik, R.E., being placed in charge as superintending engineer, with Mr. H. S. Taylor, a civil engineer, from the Royal Indian Civil Engineering College, Cooper's-hill, of considerable experience and known ability, being appointed executive engineer, with two subordinates under him. Huts were built for the party at Theekady in the Periar valley, near the top of the ghauts, paths were made and buildings for the staff commenced, and on the 28th October, 1887, I had the honour of assisting the late Governor of Madras to cut down the first tree at the site of the dam (in rain of course), and the little band of pioneers, clad in mackintoshes, stood round in a circle and drank success to the work. Since then all the anticipated difficulties have been experienced. Sickness among the staff and labourers, accidents to the works and to the workmen, mishaps through storms and persecution by wild elephants, but Mr. Taylor is still to the front as superintendent of works, working away with his usual energy, and I hope will be able to see his efforts crowned with success in the completion of the works.

Time will not allow me to relate the subsequent proceedings except in brief outline, though I have before me very interesting reports of the progress of the works. Colonel Pennycuik came to England in the beginning of 1888, and with the assistance of the authorities at the India-office procured the required machinery, and a good deal of preliminary work had been done before the work people and staff were compelled by fever to retreat to the plains on the 20th March, 1888, by which time stores and part of the machinery were arriving. In July, 1888, work was in progress again, the officers' quarters had been completed, the cutting to the tunnel was in progress, the navigable channel was being pushed on, and the site of the dam was being cleared. In September the elephants were troublesome, demolishing a shed, breaking up a barrel of Portland cement, and rolling another into the river, pulling up the furlong stones, built in concrete, and again attacking the camp

and frightening the work-people so that they deserted; by October the tunnel mouth was begun. In December a flood did some damage to the works. By the end of February, 1889, the buildings had nearly all been completed, most of the machinery had been brought up the ghaut to Theckady, the cutting up to the tunnel was in progress, and at the other end nearly completed. The works on the navigable canal also were nearly completed, the right bank escape was partly cut, and considerable progress was made in the construction of a temporary dam a short distance above the main dam, by which it was intended to divert the water when the river was low, so as to allow of the foundations being put in without hindrance from water, and to provide a head of water for working the turbines. On the 2nd March, however, an unusually heavy fresh came down the river and carried away great part of this dam, which Colonel Penny-cuik, who witnessed the accident, attributed to the masonry of the central portion being green. The works in the plains had by this time been begun, and were progressing satisfactorily.

This accident led to an alteration of the proposals, and it was determined to divert the stream by a cutting on one side of the river, construct coffer-dams enclosing the site of the main dam, and to build the lower part of the dam by hand, until it was sufficiently raised to hold up water for working the turbine.

The progress reports for August and September, 1889, show that incessant rain and sickness had interfered greatly with the work; but in December it was reported that the tunnelling machinery had been got to work, and the tunnel was progressing at the rate of about five feet per day. The construction of the diversion works was constantly interfered with by floods in the latter part of 1889: a pump was carried away, and so on; but eventually the cross dams were completed, and the site pumped out at the end of January, 1890, when masonry walls, forming the front and rear of the main dam were proceeded with. To the end of October, 1889, the expenditure on works had been £74,893, of which over £26,000 was on work in the plains. The operations were not closed for the season until after the 31st March.

On the commencement of the next working season, in June, 1890, it was reported that over 10 per cent. of the people were suffering from ague at Theckady, and over 6 per cent. at the dam; but work had recommenced on

the dam, and about 104 feet in length of the tunnel had been got out, and, by the end of July, 547 feet had been completed. By the end of October the walls enclosing the lower portion of the dam were so far completed, that concrete in cement was being put in. A landslide at the tunnel had done some damage. By the last report, the concrete for the main body of the dam was being built, the right bank escape was well advanced, the tunnel and cutting were in progress, and the navigable canal was reported to be in working order, when water was available, but a very dry season had caused a scarcity of the water supply. The work may be now considered fairly started, and, so far as can be seen, there is no reason to anticipate that it will not be carried out to completion without any material excess on the estimate. Once the main dam is raised above the ordinary flood-level in the river, the difficulties in construction should diminish, and every season's work brings experience to the staff and workpeople which will enable them to work more efficiently.

I have been able only to give an outline of this interesting work, and I have dwelt on the difficulties to show that whatever might be thought of the work in this country, it is a great work for India; and though the returns to be expected from it are not as large as those realised from the great delta works, yet were they much less than there is very good reason to anticipate they will be, the indirect advantages of bringing a plentiful supply of water to a part of the country liable to be affected by drought, in any failure of the north-east monsoon, are so great that the works must pay. For myself, I hope and believe they will be carried to a successful conclusion, to the credit of the officers concerned, the benefit of the Government, and the material improvement of that part of India I have had the honour to serve in, and which, I am told, is still called by Anglo-Indians living in higher latitudes—"the benighted Presidency."

DISCUSSION.

Sir GUILFORD MOLESWORTH, K.C.I.E., said a great many large masonry dams had been made in Spain and other places, in which the distribution of material was such that they simply crushed themselves by their own weight. Twenty years ago, or more, Messrs. Graeff and Delocre, two engineers of the Ponts aux Chaussées, inaugurated a new system, of which this dam might be considered the latest development. After making most elaborate

calculations, they built some dams, which excited universal admiration, together with some amount of scepticism as to their stability; and when he was consulted some years ago with regard to a dam of this character, he set to work to discover, if possible, a formula which would save the immensely troublesome calculations adopted by the French engineers. He succeeded in so doing, and, at the same time, he found that they had only included the vertical components of the stress; and that, in fact, but for the large margin of safety they had allowed, their structures would have been dangerously weak. Attention to this point was first drawn by Professor Rankine; he obviated this, by introducing what was called a sliding factor. About a year afterwards, M. Bouvier, another French engineer, entered on the investigation afresh, and pointed out the defects in Messrs. Graeff and Delocre's calculations. His calculations were exceedingly elaborate, involving about two and a-half foolscap pages of printed matter, and the use of the integral calculus; but the formula he (Sir Guilford Molesworth) devised, could be worked out for any dam in ten minutes. Curiously enough, he found, in working out this formula, that, within practical limits, the weight of the material made no difference in the dimensions, owing to the fact that the additional weight threw the stress further back, thus compensating for the additional weight. He worked out a large number of cases by M. Bouvier's method and his own, and found there was practically hardly any difference in the result, except a slight and unimportant difference in the rare case when the reservoir was empty. The difference between himself and Colonel Pennycuik depended, he thought, on a slight misunderstanding by that gentleman of M. Bouvier's paper.

Sir THEODORE HOPE, K.C.S.I., said there was one feature of this work which seemed to him, when the project came before him as Public Works Member of the Government, to entitle it to the very earliest possible consideration, and that was that the water which was to be impounded was derived from a practically perennial source. They had heard a great deal from time to time, especially since the Madras and Bombay famines of 1876, of the necessity for irrigation works, which were held by some people to be almost a panacea for famines in India, and consequently the number of irrigation schemes pressed on the attention of the Government was almost beyond conception. But when they came to be considered calmly and carefully by engineers and civil officers, it became evident that in many cases they would hold water well in ordinary years, but in years of famine would contain no water at all; because the sources would almost inevitably dry up in the event of a long continued drought. Consequently the Government had to recognize the principle that, unless an irrigation work depended for its supplies either on the perennial snows of the Himalayas, or some range of forest-clad mountains, such as parts

of the Western Ghats, it should not be undertaken. If any proof were required of the soundness of that position, it might be found in the number of irrigation tanks, some of vast dimensions, which were constructed in a hurry in certain parts of India, and which were supposed at the time to be not only useful relief works but preventives of future famines, but which were now known to be likely, on an emergency, to be devoid of a single drop of water. This Periar scheme, however, having the necessary qualifications, at once took the lead of all others in Southern India, and it was a great pleasure to him to have been able to hand to the Government of Madras the sanction of the Imperial Government to the work being undertaken. There was no doubt it would be conducted to a successful conclusion, and would remain for many centuries a monument of the talent of the engineers of Madras Presidency, which would vie with any of the vast irrigation works left by preceding Governments. The admirable manner in which Colonel Hasted had described the project showed how completely he justified the high position he had attained in India.

General MULLINS said he was well acquainted with the country to be benefited by this work, which he knew had suffered for many years from a scanty supply of water. This scheme raised many interesting points of engineering; it had been under consideration for many years, and though it would never pay like the great delta works, it was of the greatest importance to the locality. It was quite true that famines could not be prevented by irrigation works to any very large extent, because most of the rivers were liable to fail when the monsoons were scanty. There were some large works, such as those on the Godavery, the Kistnah, the Cauvery, and one or two smaller rivers, which could always be relied on, but to prevent the serious effects of famine railway communication must be extended, so as to afford the means of bringing food where it was required. During the greater part of his service in India he was almost entirely connected with irrigation works, and was naturally in favour of them, but the opportunities now left them were not very numerous. In the higher parts of the catchments of the great rivers, and elsewhere, much might still be done to store up water which now ran uselessly to the sea. This project would probably have a very considerable effect in inducing officers of the Public Works Department to undertake other works, even though on a smaller scale, where there was a good supply of water. Southern India possessed thousands of reservoirs, usually called tanks, some of very large size, which in ordinary seasons were very useful, but it was not possible to ensure their supply in seasons when the rainfall was much below the normal.

Mr. PENNINGTON said he could confirm what had been said with regard to the possibility of carrying out other minor schemes in Southern India.

Mr. W. MARTIN WOOD confessed to some little feeling of disappointment that this paper, excellent as it was, did not take a somewhat broader scope. He was under the impression that this Periar dam was only part of a larger project which other Madras engineers were familiar with—the Toombudra scheme, which had been talked of for many years, and which also would draw its supply from perennial sources, and would be of incomparably greater service. He was very glad that the Government had at last sanctioned this Periar project, which he believed had been on hand, more or less, for 80 years; but, with regard to the Toombudra scheme, Sir Arthur Cotton, a predecessor of Colonel Hasted, wrote of it, “I would begin with the proposed Toombudra tank as being the grand fundamental work for this Residency, in respect both of famine and of ordinary years, both of irrigation and navigation. It is indeed surprising that it is only quite of late years that this grand discovery has been made, that the Presidency possesses a basin for a reservoir of stupendous dimensions, at a level commanding the whole Peninsula, so favourable in all respects that it can be constructed at a perfectly nominal price compared with the value of the water Without any additional works whatever this water would be available in the dry season for the Irrigation Company’s works for the Kistnah delta, and for the Godavery delta—for the Kistnah anicut commands the Godavery work.” Again, with regard to its connection with other works, including Periar, he said, “The further use of the Toombudra tank, after supplying the present Irrigation Company’s works, and the Kistnah and Godavery works, with water in the dry season, and local irrigation in Bellary of half a million acres, the further use I would make of this tank is for it to supply two nearly contour canals, one across the Kistnah and Bheemah, and passing near Hyderabad to the Godavery, above the hills near Dthoomagnden, receiving contributions from both the Kistnah and Bheemah, and irrigating a large extent of land in Hyderabad.” Other particulars were given, of great interest to engineers; and he wished they could have had a more general view of this question. It was quite true, as Sir Theodore Hope had said, that sometimes there was a difficulty in getting water. You must either have rivers fed by perpetual snows, or by monsoons on the Western Ghats; but you have both those unflinching sources of supply. Millions of tons of water rushed in waste to the sea year by year, passing these arid plains; and it was high time that men who had a proper pride in the Indian Empire should take a right view of the matter. Irrigation was a panacea for famines, if rightly understood. It was no use making apologies for works which had failed because they were badly constructed, and then saying you must have railways to carry the food where it was wanted. Water would make the food grow. The wealth of water which India possessed by the gift of nature was equal to the

gold of Australia or the diamonds of South Africa. It was not only a question of irrigation, but of navigation and cheap transit, which was the greatest need in a country where distances were great and industrial energy weak. Heavy transport by steam on railways could never be cheap on long distances. From 150 to 180 millions had been spent on railways in India, involving a heavy debt, whilst only 25 or 26 millions had been spent on water storage. The comparison was a reproach to the English as a practical people. Competent engineers could easily be found, but they had too often been snubbed. Some twelve or fifteen years since, Mr. Thornton, the able Public Works Secretary at the India Office, read a paper in these rooms on the subject, which was still worth referring to. He was glad they had got so far, but even in Colonel Hasted’s paper he did not find that the question of navigation was even referred to. The only criticism he would pass on the paper was with reference to the observation made on the depreciation of the rupee; and on that he would say that as the expenditure, except on the machinery, was all in India, that did not affect the question, as the rupee there was as good as ever. But that point had a bearing on the comparison between railways and canals; in the former case, more than half the capital had to be expended in England, while on water-works it was not more than a fourth or fifth. If those who were paying attention to this subject would only make a fresh start, and look at it independently, he thought they would see that a new departure was needed.

Mr. HYDE CLARKE regretted that Mr. Martin Wood had been disappointed with a paper which, to his mind, threw a great deal of light on a subject which had been often discussed in that room and at the Institution of Civil Engineers a quarter of a century ago. Irrigation and railways were both of great importance; but Mr. Wood still seemed to maintain the doctrine, which he had hoped had passed away, that nothing was to be done to put India on a level with other countries in the matter of railway transport. It was many years since he had taken any part in hydraulic engineering, but there were several points in the paper which came to his mind very strongly. In listening to Mr. Wood or to Sir Arthur Cotton, one would think that irrigation and inland navigation was the easiest thing in the world; you had only to spend a little money, and could at once provide a supply of water and the best means of communication; but this had been found to be a mistake. In the beginning of the Indian railway system they had to fight against the traditions of Europe, and a strong prejudice in favour of cheap water communication; but though the canals still existed, railways had been carried out with great advantage to the country. India had profited by the experience of Europe, and had applied inventions which were quite recently hardly known here. He recollected when the turbine was scarcely used in England, but now it was

being utilised in those very works. Another great labour saving appliance was the wire tramway, which in Italy had enabled many mountain mines to be worked which would otherwise have been abandoned, and having always believed in it, he was glad to see it was being used in India. Another interesting point was the way in which engineers went back to their former convictions. There had been great contests how dams should be constructed, but none had been more successful than the dykes of Holland, which were made of earth, and resisted even the inroads of the ocean itself. He wrote the first work on this subject in this country, which for some time was the standard at the Institution of Civil Engineers; and it occurred to him that, using concrete instead of rubble masonry was really only returning to first principles. The value of the paper was in showing that it was not quite so easy to carry out irrigation works, especially of this particular character, where the water had to be transported from one side of the ghauts to the other; and that, until you had completed the work, you had, in fact, done nothing. Any failure, either from accident or natural causes, might throw you back for years. In the case of a railways, almost every portion was of some value; but, in the case of a great irrigation work, you must wait until the end before any result at all was obtained. India wanted both railways and canals; and both India and England wanted information on both subjects. On this account, such papers were very valuable, and he begged to propose a vote of thanks to Colonel Hasted for it.

The vote of thanks having been passed.

Colonel HASTED said that the Toombudra project was a very large work which Sir Arthur Cotton proposed, the details of which he did not remember; but he believed it was to carry water all over the south of India. No paper on irrigation works in Madras should be read without some mention of Sir Arthur Cotton. He first heard him speak on the subject some thirty-six years ago, in that room; and he only wished Sir Arthur were there to take part in that discussion; he would always take part in a contest between railways and irrigation. The Toombudra project was a magnificent conception, and a matter of imperial concern far beyond the power of the Madras Presidency to deal with. Most of these things were a question of money, and its scarcity often put a stop to very promising schemes. He did not think navigation could be carried on in connection with the Periar. He recollected what took place on the Kurnool Canal, which was undertaken by the Madras Irrigation and Canal Company; about 190 miles were constructed, with about forty large locks, and boats were placed upon it; but, so far as he knew, the navigation was a failure. The Government eventually took over the canal, and had the boats. But the people had never seen boats, and did not understand them; and they were never used. Probably it would be the same here. If there were

an outlet to the sea it would be different. His reference to the rate of exchange was a purely personal grievance, but he did not appreciate the benefit to India of the present rate of exchange.

The CHAIRMAN, said he was very glad to hear the remarks which had been made about Sir Arthur Cotton, for he did not think the subject of Madras irrigation should ever be mentioned in a public assembly without his name being saluted by any one who had been connected with Madras, and a letter had been received from Sir Andrew Clarke, expressing his approval of the paper—a copy of which had been sent him. For his own part he could only say that it had given him great pleasure to be present. This Periar project had been a pet of the Madras Government from generation to generation, and he was delighted to see it had advanced so far, and trusted it might soon be completed.

Correspondence.

ELECTRICITY IN RELATION TO THE HUMAN BODY.

In the *Journal* for May 15th, Mr. Pennington wrote: "Dr. Harries is mistaken in supposing he was the first to discover what has been called electric osmosis." It is not within my knowledge that I have ever supposed anything of the kind. On the contrary, if your correspondent will read the paper by Mr. Lawrence and myself (*Journal*, 13th March, 1890), on page 320 he will find, in the paragraph commencing "Experiments have been made both in Germany and America, within the last few years," &c., sufficient refutation of his statement.

If, further, Mr. Pennington will refer to the *Medical Press* (11th Dec., 1889), the *Lancet* (25th Oct., 1890), or the *Electrical Review* (1st Jan., 1890), he will acquire a little more information on the subject than he at present seems to possess.

Cataphoric medication needs no elaborate apparatus for its performance. The "machines" and "instruments" mentioned are unnecessary, and calculated only to hedge the process round with costly superfluities.

May I ask if the "Professor" quoted by Mr. Pennington be identical with the inventor of the "Panelectric Treatment of Disease," and promoter of "A New System of Home Nursing for the Indigent" (of which, by the way, a Mr. J. B. Pennington is to be one of the "Treasurers and Trustees")? If so, the *raison d'être* of Mr. Pennington's letter is obvious.

ARTHUR HARRIES.

DECORATIVE PLASTER-WORK.

I read with great interest Mr. Robinson's lecture of April 14th on "Decorative Plaster-work," especi-

ally with reference to its use on old English ceilings' as I have myself recently decorated the hall ceiling of this house with an imitation of a ceiling in Aston-hall, near Birmingham, of I presume the time of Henry VIII. or Elizabeth. For economy's sake, however, my reproduction is formed of cheap ordinary wood moulding, costing $\frac{1}{2}$ d. a foot or thereabouts, about $1\frac{1}{4}$ inch deep. This when mitred together, in accordance with the pattern of the original, and pinned up to the ordinary plaster ceiling with long French nails driven deep into the joists, then stopped in all the joints and interstices with plaster of Paris, painted white, and finally whitewashed, has all the effect of plaster moulding, and makes a firm and durable decoration.

Wood-moulding, however, can only be used for rectangular or geometrical patterns, and as I wish to commence one which I took from Haddon-hall, containing curves and half circles, I should be glad if any one will inform me whether some fibrous and elastic material, such as thick paper, might not be used and answer the same purpose, as it could be more easily worked in curves than wood.

LOWTHER BRIDGER.

Old Manor-house, Walton-on-Thames,
17th May, 1891.

FAST AND FUGITIVE DYES.

I listened with great interest to Professor Hummel's lecture on the 13th inst., and learnt, with surprise, that several of the coal-tar colours will stand the light. In my own business (paper-staining) body colours are used, not dyes, although probably the colouring matters are practically the same in both cases, and it is of the utmost importance to us to select colours so neutral in their character that they will mix one with another without suffering by the contact, but it is also essential that the tints resulting from such admixture shall be fairly permanent when exposed to an ordinary amount of light, such as is usually found in the interior of most houses.

If time had permitted, I should have liked to ask Prof. Hummel whether the colouring matters that he had proved to be fairly permanent in light, as dyes, can also successfully be employed as pigments. It would also be very desirable to know whether the dyes most permanent to light are in any way dependent upon arsenic for their durability, consequent upon arsenic being used in the development of the colouring matter, or in the mordant. Colour makers assure us that colours containing arsenic stand light better than others of similar tint prepared without it, and therefore advocate the use of it; while sanitarians insist on the urgent need for the suppression of the use of arsenic, not only in the colouring matters of wall-papers but in dyes and paints of all kinds.

A recent number of the *Boston Medical and Surgical Journal* recorded a case of chronic arsenical poisoning extending over four years, which was distinctly traced to an arsenical paint "mixed with lead and oil," and having "a smooth glazed surface." In the *Pharmaceutical Journal*, of May 9, reference

is made to British cotton prints exported to Norway, in which arsenic was found in such quantities as to be dangerous to the wearer. You will see, therefore, that the question of the presence or absence of arsenic in any dye or colour is esteemed of vast importance to the public health, not only at home but in other countries, and I think that no dyes or pigments depending for their successful employment upon the use of arsenic can be safely recommended for general use. If Prof. Hummel would reply in the *Journal* to these queries, doubtless the information afforded would be valued by many others as well as by

Yours faithfully,

F. AUMONIER.

110, High-street, near Manchester-square, W.,
20th May, 1891.

MEETINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.

MAY 28.—CHARLES LEWIS TUPPER, B.A., Bengal C.S. (Punjab), "The Study of Indian History." The Right Hon. SIR MOUNTSTUART GRANT-DUFF, G.C.S.I., C.I.E., will preside.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 25...British Architects, 9, Conduit-street, W., 8 p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m. Annual meeting.

Linnean, Burlington-house, W., 3 p.m. Annual Meeting.

TUESDAY, MAY 26...Royal Institution, Albemarle-street, W., 3 p.m. Mr. William Archer, "The Clobber Period of Stage History."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual general meeting.

Statistical, School of Mines, Jermyn-street, S.W., 7½ p.m. Dr. J. Venn, "The Nature and Uses of Averages."

Photographic, 50, Great Russell-street, W.C., 8 p.m. Discussion on "The Influence of Development in Gradations."

WEDNESDAY, MAY 27...Geological, Burlington-house, W., 8 p.m.

British Astronomical Association, Barnard's-inn-hall, Holborn, E.C., 5 p.m.

THURSDAY, MAY 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. C. L. Tupper, "The Study of Indian History."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. C. Mackenzie, "The Orchestra Considered in Connection with the Development of the Overture." (Lecture II.)

Guild and School of Handicraft, Essex-house, Mile End-road, E., 8 p.m. Mr. F. I. Thomas, "The Relation of the Architect to the Handicraft."

FRIDAY, MAY 29...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. David Gill, "Work in a Modern Observatory."

SATURDAY, MAY 30...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. H. Church, "The Scientific Study of Decorative Colour."

Journal of the Society of Arts.

No. 2,010. VOL. XXXIX.

FRIDAY, MAY 29, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Conversazione is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 17th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

Further particulars as to arrangements will be announced in future numbers of the *Journal*.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, May 5, 1891; SIR CHARLES WILSON, K.C.B., K.C.M.G., F.R.S., in the chair.

The paper read was—

ARMENIA AND ITS PEOPLE.

BY CAPTAIN J. BUCHAN TELFER, R.N.,
F.S.A., F.R.G.S.

At a time when the friends of Armenia are agitating to see enforced the observance, by the apparently helpless or procrastinating Turk, of the Article in the Berlin Treaty*

* Art. 61. "The Sublime Porte undertakes to carry out, without further delay, the ameliorations and reforms demanded by local requirements in the provinces inhabited by the Armenians, and to guarantee their security against the Circassians and Kurds. It will periodically make known the steps taken to this effect to the Powers, who will superintend

that was framed for ameliorating the condition of an intelligent race of Asiatic Christians, a concise description of the history of their country, its resources, their Church, religious tendencies, customs, and aspirations, cannot but serve to diffuse sympathy in their cause, and excite far wider interest in their welfare. It were well did England add still one other bright page to her history as the deliverer of the oppressed, so soon as circumstances will admit, by relieving a trodden-down people, well worthy of her regard, from a continuance of the wrongs and sufferings they have endured during many centuries, and which have contributed to the disruption of populations and extensive obligatory exile, without, however, resulting in vagrancy or degradation of the national character.

The territory known geographically in ancient times as Armenia was of somewhat important dimensions, having a superficies which may be roughly estimated at fully 140,000 square miles. The greater portion lies at an altitude above the sea varying from 3,000 feet to 7,000 feet, except in one direction near the Caspian, where the land, sinking to a lower level, offers indications of having been submerged at some remote period.

Armenia proper was bounded on the north by Georgia, or Iberia, and Colchis, now Mingrelia; on the east by the Caspian and Persia; on the south by Mesopotamia and Assyria; and on the west by Asia Minor; all that part to the east of the Euphrates, hitherto so little explored, having comprised Greater Armenia, the whole to the west of the river being named Lesser Armenia. As at present divided, the country is in three unequal parts, the northern subject to Russia, the eastern belonging to Persia, the western being included in the Turkish dominions—regions traversed by mountainous ranges of considerable height, such as the Taurus, the Gordœan, and Moscian, including *Masis*, better known as Ararat, the pride of the Armenians, upon the highest peak of which, 16,916 feet above the sea, the ark rested after the Flood, so at least has said local tradition for many ages. The Tatars call it *Parmâk-dagh*, "finger mountain," and *Aghyr-dagh*, "heavy mountain," but we have to go further south, and set our

their application." The Treaty of Berlin of 1878 was signed "on the thirteenth day of the month of July" of that year, by the Plenipotentiaries of Great Britain, Germany, Austria, France, Italy, Russia, and Turkey, the signatories for Great Britain being the Earl of Beaconsfield, the Marquis of Salisbury, and Lord Odo Russell.

eyes on *Nadyr* to behold the Ararat of sacred history. The Tigris and Euphrates, names familiar to Englishmen, spring from those heights, also the classic Araxes and Kour, the Tchoruk-sou, and other streams of minor importance. To the water system should be added the lakes, three of which, Van and Ouroumyeh, both of saltish water, and Sevan, of fresh water, are of considerable dimensions, the largest, Van, in which is the seat of a Patriarch, being 80 miles long and 40 miles broad. These three lakes are at an altitude above the sea respectively of 5,130 feet, 4,000 feet, and 6,340 feet.

The soil of Armenia is extensively volcanic, as evidenced by numerous mineral springs, and by the unmistakeable characteristics of some of its mountains. Apart from large volcanic formation, the country presents spacious surfaces of porphyry, and among the minerals may be named augite, felspar, basalt, jasper, various kinds of marble, and alabaster of great purity. Gold has been found, there is silver, an abundance of copper, iron, cobalt, magnesium, zinc, and coal, bitumen, alum, nitre, rock-salt, sulphur, and naphtha.

Although large tracts of land exhibit a forlorn condition, for want of planting and cultivation as well as from natural causes, a variety of useful wood grows in more favoured districts. Distinct kinds exist of the oak, poplar, and plane-tree; the beech attains gigantic proportions, elm and maple are abundant, and the fir reaches a large size. The plantain is seen in so great perfection probably only in Armenia, while in the extreme south the karoub, or locust, and olive, thrive and yield generously. Amongst fruit, peaches hold the first place; they are superb, scarcely to be equalled in any part of the globe, and sufficiently plentiful to be stored in pickle for winter use as a substitute for vegetables then scarcely obtainable. The word *persica*, whence our designation, is derived from the name Persia, from which country the peach was originally imported. The choicest of other fruit are apples, pears, nectarines, apricots, plums and pomegranates, and the most luscious of melons, and, even though the vine does not grow anywhere on the great range of the Caucasus at an altitude exceeding 3,570 feet, it thrives in Armenia at 5,100 feet, the wines of Erivan, Elizavetopol, and Karabagh being the most esteemed. Corn grows almost everywhere, and maize, rice, barley, tobacco, cotton, flax and silk are ex-

tensively cultivated; also, but in a less degree, madder, first introduced into France (1774) by an Armenian named Ohannes Althour. The lily and the rose are the flowers of Armenia.

There is probably no other country in the world in which the sportsman is offered so great scope for indulging in his favourite pursuit, and facilities of travel now place Armenia within comparatively easy reach, Trebizond being within two days steam of Constantinople, Erzeroum within ten days journey of Trebizond, and distant four to five days journey from Van—this on Turkish territory. Erivan and the plains of the Araxes, in Russian Armenia, may be reached in three days from Batoum, the journey to which place from Charing-cross, *via* Odessa, is to be accomplished in eight days. The latter is decidedly the preferable route, travelling in Transcaucasia being perfectly safe, although it is considered a wise precaution to keep under cover for the night at one of the many post-stations on the road. In Turkey, on the contrary, so long as the present state of insecurity lasts, a good staff of servants and a trustworthy dragoman are necessary encumbrances, as well as an escort of *zaptiehs*, or mounted police, and tents must be carried, the dwellings on the hills being horribly dirty, and abounding in vermin of every description. Birds are plentiful, such as the pheasant, partridge (which, with the stork, sacred to hospitality, and crane, is frequently named in popular songs), pigeon, bustard, plover, snipe, besides an inordinate variety of water-fowl, also quail; and they who look for heavier game will meet with the leopard, hyæna, lynx, and bear in the Dersim district; wild boar, numerous in the valley of the Tchoruk sou; deer, in the highlands of Moush; wolf, abounding in winter, but very shy; fox, and wild ass; also different species of the wild goat about Van and Ararat.*

Armenia has been famed, from the earliest times, for its horses, which supplied the studs of the fastidious kings of Persia. Her warriors of old proved their invincibility as fearless and efficient horsemen on many a hard-fought field, history recording that the great Tigranes had no less than 150,000 mounted men under his banner, besides 17,000 men and horses

* I secured the skin and horns of a magnificent *Hircus Agagrus* that was shot on the slope of Ararat by a Kurd, whom we encountered bringing down his prize laid across the back of an ass. The specimen is now in the Natural History Museum, South Kensington.

in complete armour, after the manner of the armoured horses of early Greek authors. Although the same attention is no longer devoted to the rearing of the useful quadrupeds, some hundreds are sent annually into Russia from the valley of the Terter, in Karabagh, where the Russian authorities keep large studs for brood mares. Van is a good mart; and very useful baggage horses are to be obtained at Erzeroum for £7 to £11, saddle-horses, of better breed, being priced at £14 to £18. These animals are bred chiefly by Kurds, and are either what may be termed pure Kurds, or of mixed Kurd and Arab blood. Further south, pure Arabs preponderate, thoroughbreds at Diarbekyr costing from £45 to £55. The Kurd horses, wiry and enduring, docile and easily broken, stand from 12 to 14, and even 15 hands, being slighter than Russian horses, which are preferred for harness and sleighing; the *Ghazali*, from Russian Armenia, and the *Deliboz* "gray-mouthed," on the Russo-Turkish frontier, being the most prized of Kurd horses.

The trade in fish, taken from Lake Van and Sevan, is considerable, that from the former being a kind of herring, and from the latter the *salmo ferox*, or great lake trout, and there is scarcely a stream throughout the land that is not a trout stream, the upper reaches being the more plentifully stocked, where the fly or minnow will speedily testify to the exhaustless nature of the supply at all seasons, except in the early summer, when the water courses are flooded and discoloured by the melting snows. The streams in the valley of Tortoum, of the Merjain-sou, and of the Euphrates (*Kara-sou*) upwards from Kiragosak, may be quoted as among the choicest for trout. The *shahmahy*, resembling the herring, esteemed a great delicacy when smoked, is taken in the Araxes and Kour, also salmon, plentiful enough at the junction of those rivers near Djevatt; it is salted, and to be found in all the principal bazaars. Sheep, nurtured on the richest of pastures, where the flocks are guarded by the most savage of dogs, are exported into Turkey in large numbers, and many are sent into Syria.

Such are the resources of a land specially favoured, whose inhabitants have been cruelly used at the hand of man during many hundreds of years, and why? For the sole crime of being a Christian people in a region coveted because flowing with milk and honey! Climate naturally varies greatly in a country of such extent, and although it lies principally in the same parallels of latitude as Greece, Italy and Spain,

the average temperature is considerably lower. The severity of winter has been dwelt upon by Xenophon, and the earliest geographers, in the writings of the "Fathers" of the Church, and by travellers at various epochs, and it will be in the recollection of those who read the reports from correspondents with the Russian and Turkish forces during recent wars, that the troops in the contending armies had to endure serious hardships throughout the winter months. In many parts, even in summer, the nights are very trying.

For the early history of the country under notice, chroniclers have been dependent chiefly on tradition. Moses of Khorene, the noted writer of the 5th century, was the first to compile a history of Armenia,* out of records he found in the works of Mar-Ibas (Katina), a learned Syrian, 150 B.C., who derived his information from writings that had been preserved in the archives of Nineveh, Moses of Khorene himself asserting that he had seen, in the archives of Edessa, a record of those kings of the dynasty of Arsaces who had reigned in Armenia. According to that great historian, the Armenians claimed descent from Haïg, the great grandson of Japhet, whose immediate successors were the first to settle around Ararat. They called, and still call, themselves Haïs, and their country Haïasdan, after that Haïg, the name Armenia being traced to Aram, 2000 B.C., one of Haïg's successors, who, having conquered and annexed large territories, his followers were called after him Aramian, whence Armenian. Strabo, however, tells us that the country received its name from Armenus, a Thessalian, one of the companions of Jason! We read that Vahè, the last of that dynasty, perished at the battle of Arbelles, where he commanded a force with which he had gone to the relief of Darius in his conflict with Alexander the Great, who appointed a governor to rule over Armenia, thereafter a possession of Macedonia. Perhaps a fair start in history may be made with the conquest of Armenia by the Parthians, the expulsion of the last of the Macedonian governors, and the establishment on the throne, about 150 B.C., of the brother of Arsaces the Great. But even this is a disputed point, for the intricacy in the succession of sovereigns becomes almost bewildering, from the frequent changes that occurred in the government, whether in consequence of invasion from a neighbouring State, by

* Translated into Latin and published, with the Armenian text, by the brothers Whiston; London, 1736.

rebellion, or through the abdication of a monarch.

The first of the dynasty of Arsaces who reigned over Armenia was named Vagharshag. In his anxiety to rule his people with equity, he resorted to the expedient of attaching two confidential officers to his person, the duty of the one being to remind him that he was to blend mercy with justice at any moment that he should be inclined to act with undue severity or with cruelty; while the other was to insist on the award of merited punishment if the monarch were disposed to show undeserved leniency. At a later period, the hard-won victories of Pompey over the great Tigranes and his renowned father-in-law, Mithridates, resulted in Armenia becoming nominally subject to Rome. It is worth noticing here that Ardavazt, the first to ascend the throne as a vassal of the empire, having been suspected of treachery, was made prisoner by Anthony, and eventually decapitated by order of Cleopatra.

Passing over the struggles between Romans and Parthians, each vying for supremacy, it appears that in the early part of the third century the ruling prince was assassinated by secret emissaries from the Persian king, who soon mounted the throne he had thus rendered vacant. The whole of the royal family was put to death, with the exception of a daughter, and a son named Tiridates, saved from massacre by faithful dependents, and carried away to Rome, where he afterwards served with distinction in the imperial ranks. Upon the death of the Persian usurper, Tiridates received his father's sceptre at the hands of Diocletian, and ruled peaceably during many years, his reign exhibiting a remarkable epoch, inasmuch as he and his subjects became converted to Christianity. In 428, the dynasty of Arsaces came to an end, by the deposition of a tyrannic sovereign, and the first of Persian prefects was appointed in conformity with the wishes of the *Naharar*, or military chiefs of the several provinces, a form of government that continued for two hundred years, to the inconceivable misery of the Christian population, forced to the worship of Zoroaster. They were forbidden all intercourse with Byzantines, the Greek tongue was no longer to be studied, and Greek books and works of art were ordered to be destroyed—terrible blows to literature and progress. The vanquished refused to submit tamely, and rather than have their religious convictions interfered with, they broke into open rebellion

under the leadership of Vartan, "the Mami-gonian," and fought desperately for their liberties. Yielding ultimately to superior force, they were nevertheless successful in securing certain favourable conditions, including freedom of worship and the enjoyment of their accustomed literature.

After these events followed the overthrow, by the Arabs, of the hated Persian domination, and Armenia was ruled by *Osdigans*, prefects nominated by the Khalifs of Baghdad and Damascus, men who, in most instances, practised unparalleled cruelties. This, also, was a period during which the Armenians proved their mettle as warriors, frequently defeating the forces of their oppressors with the inconsiderable numbers, invariably horsemen, they were able to muster on the field.

This was reached the year 859, when the Bagrations* began to reign in the person of Ashod, prefect of the Khalif of Baghdad; Basil I., the Byzantine emperor, claimed as a countryman by the Armenians, being the first to recognise the new monarch. An inconsiderate act, however, on the part of Ashod's successors, led to a series of disasters which decided the fate of this dynasty.

In 1024, the reigning king besought the Emperor at Constantiple for protection against his enemies, engaging, in return, to make over to the Empire, at his own death, the royal city of Ani and the province in which it was situated. When the time came, the refusal of the people to acknowledge this obligation subjected them to a succession of invasions by the Greeks, which, nevertheless, were invariably repulsed. During a temporary truce, in 1045, the king was prevailed upon to visit the emperor, Constantine IX., in his capital, when he was treacherously seized, exiled, and put to death. The anarchy that followed led to the destruction of the unfortunate kingdom, Constantine's act proving a terrible error; for Asia Minor was thrown open to the Seljouks, who overran and devastated that continent from end to end, and then attacked the declining empire itself.

Five and thirty years later, Roupen, a descendant of the late king, made his appearance in Cilicia, and drove out the Greeks who

* The Bagration, or Bagratide dynasty, ruled over Georgia during the space of 1029 years, until the annexation of that kingdom to Russia in 1801; and in the first century of our era the viceroyalty of the eastern provinces of Armenia was committed to members of this family, which is still represented by several officers holding high rank in the service of the Tsar.

had settled there. He was the first of a new dynasty which frequently came off victorious in repelling the attacks of the Seljouks, Byzantines, Egyptians, and Persians, some of the exploits on the part of its people—such, for instance, as the overwhelming defeats of Andronicus the Byzantine general and his legions, by Thoros II., being brilliant deeds of military genius and valour. This new kingdom proved of great assistance to those warriors from the west engaged in the Crusades, when in need of supplies or hard pressed, as was the case at Antioch and Iconium, services that were duly appreciated and acknowledged by the dignity of baron being conferred upon Constantine, son and heir to Roupen, a title that was borne by every succeeding prince, until the coronation of Leo. II. by Conrad of Wittlesbach, archbishop of Mayence, at the instance of Henry VII., Emperor of Germany. One of this line, named Heyton, who reigned from 1224 to 1270, a period that included part of the Fifth and the whole of the Sixth Crusade, might be specially referred to on account of his relations with Edward, afterwards Edward I. of England, during the sojourn of that prince in Palestine. The Pope, Alexander IV., was unwearied in his efforts to excite the interest of Edward in favour of Armenia—efforts renewed by Boniface VIII.; but England's knights were engaged elsewhere, and the English king contented himself with sending friars to convert the troublesome heathen, hoping thus by gentle means to avert their enmity from his would-be allies. This intercourse with Latin princes opened the way for the kings of Armenia to form matrimonial alliances with the reigning families of Antioch and Cyprus, whereby they lost sight of their responsibilities as rulers in the East, and sought to associate their interests with those of the Western Powers, their chief aim being to disburden themselves of Greek protection in whatsoever form. A pretext was here afforded to the hostile races around for going to war, and, neglected by her Christian allies and left to her own resources, again was Armenia deluged in blood. Repeated invasions by Tatars resulted in the slaughter of thousands of the inhabitants, a condition that lasted until, in a treaty of alliance, entirely advantageous to the Great Khan with whom it was concluded, it was convened that the Armenians should hold certain positions in Syria he had conquered from the Egyptians, a compact which only served to provoke the anger of the Mamelouk Sultan, who thereupon became the

most uncompromising enemy of the now little kingdom, as will presently be seen.

Marino Sanudo, a contemporary Venetian traveller, thus describes the situation of the unhappy country at that period:—

“Upon the one hand is the lion—that is to say the Tartar, to whom the Armenians pay considerable tribute. Upon the other hand is the panther—that is to say the Sultan, who day by day consumes the Christians and their kingdom. Upon the third side is the wolf—that is to say the Turk, who subverts all authority and the kingdom; and on the fourth side is the serpent—that is to say the corsair of our seas, who daily gnaws at the bones of the said Christians of Armenia.”

Three separate expeditionary forces from Egypt landed in Cilicia for the purpose of plunder and destruction, the ravages during the last invasion, 1371, causing so great a scarcity that a bushel of corn was sold in the city of Sis, the capital of the Armenian kings of Cilicia, for a sum equal to two hundred pounds sterling. The people were unmercifully slaughtered, and their habitations razed to the ground, the king himself, Leo. VI., a scion of the house of Lusignan (the last five sovereigns were of the Latin church), being carried off to Egypt, whence he was suffered to retire to Europe after a captivity of six years. He spent some time in Spain, and was then employed by the Pope to proceed to France and England for the purpose of mediating between the monarchs of those kingdoms, then at war. Leo was received by Richard II. on Blackheath—common with all the regard due to his rank, and hospitably entertained, and being thus encouraged, he endeavoured, in the course of a speech he delivered in the royal presence, at the palace of Westminster, to enlist the sympathy of the English monarch in his own cause; but the only result was the presentation of some costly gifts, and the promise of a pension equal to about one thousand pounds a year, which was not for long a charge on England, for Leo died in 1393, an exile in Paris,* and with him came to an end, perhaps for ever, the kingdom of Armenia.

At the period of Leo's death, the country was in the hands of the Persians, Turks, and Kurds, Tamerlane being sovereign paramount. In due course it became entirely occupied by the Persians, and the final doom of the Armenians as a nation was accomplished

* Armenians who chance to be in Paris, make an annual pilgrimage to the tomb, at St. Denis, of their last king, upon the anniversary of his death, when prayers are offered and a few words are usually spoken by the *doyen* of the community.

when Shah Abbas, in 1604, desiring to harass the Turks in their projected attack on his dominions, forced the entire population to emigrate into Persia, destroying towns, laying homes waste, and rendering the land uninhabitable. He treated all classes well, and founded a new city of Djoulfa for his Christian subjects; but the last bonds of unity were sundered, and Armenia has since remained simply "a geographical expression," the territory becoming the battle-field of Turks and Persians, such Christians as chanced to be in the way meeting with merciless massacre. Christianity was truly in peril, but the brave patriots, with their accustomed tenacity, gathered together in their own lands, as opportunity offered, to fight in defence of their faith, or, when worsted, to supplicate their conquerors for freedom of worship and unrestrained action in the election of the dignitaries of the church to which they belonged, privileges that were eventually conceded upon acquiescence in heavy taxation. The consequences of such an arrangement proved fatal to many an ecclesiastic through assassination or compulsory deposition, the vacancies thus caused making room for new elections and the exaction of fresh fees! During these troubles, the Pope's emissaries—Jesuit missionaries—were not slow to profit by the general distress, and, in promising the protection of the Western Powers, many proselytes were made; a state of things that continued with varied success until the close of the last century, when Russia's influence began to predominate; for in 1808, seven years after the annexation of Georgia to the Russian Empire, the first election of a patriarch took place in accordance with the ancient usages of the Church.

At this point a very natural question arises. Has Armenia, during her long and eventful history, ever had a beneficial influence on neighbouring populations? The reply is necessarily in the affirmative, for at such times as she enjoyed a certain degree of independence, her influence over the Georgians, and other as well as Christian people, was decidedly to their advantage, but chiefly as regards religion and literature. Armenia was foremost in supporting Christianity amongst her neighbours, the Georgian Bible being an exact translation of the Armenian version, of which more hereafter, and the Georgian Church having been in a manner dependent upon that of Armenia until the 6th century. Mesrob, the great divine and missionary of the early part of the 5th century, who invented the

alphabet for the language of his country, which is traced to the Iranic of the Aryan family, was also the first to introduce a system of written characters, the ecclesiastical alphabet* for the Georgian tongue. So far back as the 7th century, Armenian missionaries, under the leadership of the Armeno-Albanian bishop, Israel, found their way to the northern shores of the Caspian, where they were successful in proselytising the Huns who had made that region their home, prevailing on those barbarous tribes to give up the worship of their giant god, to discontinue the sacrifice of horses, and to abandon polyandry and other pagan customs; labours that are related with much detail by Moses of Kalkant, the historian of the 9th century, of whose works an edition has appeared in Russian. To Armenia is fairly due the credit of having carried a certain degree of civilisation into the more remote parts of the Caucasus. Nor should be overlooked her important services to the Eastern Empire during its struggles from the 5th to the 10th centuries, when several of her sons, such as Maurice, the Leos, Romans, Basils, Constantine VII., John *Zimisces*, and others, were invested with the imperial mantle; Isaac was created Exarch of Ravenna, and many others were entrusted with the highest military commands, preferred, in many instances, to the Greeks themselves; and it may be added, that if the annals of what is now British India were consulted, it would be found that Armenians were before us in the Peninsula as traders and missionaries. The small Armenian colony at Kauboul has a highly interesting history.†

If we except the few Byzantine sacred edifices still existing in the west of Transcaucasia, chiefly the work of Justinian when introducing Christianity in those parts, ecclesiastical architecture, as seen in Georgia, owes its origin to Armenia, and is remarkable for solidity and grandeur of style, the chief feature, apart from the peculiar stunted spires, being that churches, one and all, and of whatsoever epoch, are constructed, within and without, even in the least accessible places, entirely of wrought stone. They are usually in the form of a cross, the dome in the centre being supported by columns or pilasters at the angles.

* Pharnawaz, the first king of Karthly (Georgia) 302-237 B.C., is credited by the Georgians with having originated the military or vulgar alphabet, some letters of which assimilate the Zend alphabet, others bearing a striking resemblance to the Sanscrit.

† See "Fourteenth Report of the Church Missionary Society's Mission to the Afghans," printed at Lahore, 1880.

The imposing appearance of many of these edifices, even after having been visited by the destroying infidel, and having endured the neglect of centuries, testifies amply to what must have been their original strength.

After that Tiridates had returned from abroad, and ascended the throne of his ancestors, he invited a company of Grecian workmen to his dominion, possibly from a desire to introduce a taste for higher art among his people; and he employed them to construct a residence for his favourite sister at a place now called Bash Gharny, near his capital. I should say it was a temple, rather than a palace, of the Ionic order, as indicated by its superb remains. It probably owes its complete destruction to an earthquake, of which, however, there appears to be no record, while there is evidence that it was still standing in the ninth century. A lion's face, portion of the frieze of grey porphyry, of which the entire edifice was constructed, is on the table before you. I am not aware of the existence in any other part of Armenia of another example of Grecian architecture, as being erected by the Armenians themselves. I chanced to converse with several Greeks—the Armenians call them *Berzen*—at a colony near Nahitchevan, who quite believed themselves to be the descendants of those who built the *Takht Dertud*, "throne of Tiridates," as the natives call the shapeless mass of gigantic porphyry blocks.

During that most brilliant period of literature in Armenia, the fourth and fifth centuries, students travelled to Constantinople, Athens, Rome, Alexandria, and other seats of learning, and many remarkable men were produced, some of whom translated the writings of ancient authors, and to whose industry the world owes the preservation of many fragments the originals of which have long since perished—for instance, the works of Bar Deisan, a noted Gnostic of Mesopotamia; of Philo, the Greek; of Eusebius, "the Father of Ecclesiastical History;" Faustus of Byzantium, and others, besides many homilies and various writings. A temporary revival took place in the 12th and 13th centuries, of which epoch is Haithoun, known as the author of a "History of the East," written in Latin during his residence in France, and who, it is believed, excited the sympathy of Edward I. and Edward II. of England in favour of his country. The permanent revival, however, of national literature, dates, it may be said, since the Benedictine monks, the Mekhitarists, so

named after their founder, Peter Mekhitar, of Cappadocia, became settled at Venice in 1717, where, except for the conflagration that brought them to sore distress a few years ago, they have continued a prosperous and renowned community, ever constituting it their task to keep alive the tongue of their native land, and to spread abroad its history and literature by the publication of translations into various languages from the works of their own authors. An interesting collection of popular Armenian songs, by the Rev. Leo P. Alishan, D.D., of the Mekhitaristic Society, made its appearance some years ago, being dedicated to the people of Great Britain. One of the songs is a lament on the forced emigration into Persia of the Armenian people, by Shah Abbas, nearly three hundred years ago. I cull from it this one verse—

"Oh! that my neck were broken, blind my eye,
Then poor Armenia I should see thee not—
For greater happiness 't would be to die,
Than live and witness thy unhappy lot.

It seems adapted to present circumstances.

The Armenian communities in various parts of Turkey, in Poland, at Amsterdam, Leipzic, Marseilles, in Great Britain, and British India, have had, and probably still have, their printing presses, and at Jerusalem printing was first introduced by Armenians.

It is needless to dwell on the heathen practices of the dark ages; better, by far, to admit that the Armenians, as a nation, are to be included amongst the earliest Christians. Eusebius, in the early part of the 4th century, asserts, and the tradition is firmly believed to this day, that Abgarus, the King, hearing at Edessa of Jesus Christ and the miracles he wrought, wrote to invite the Saviour of men to visit his dominions* and heal him of a dangerous malady, and received, in reply, a letter, together with a portrait of our Lord; and it is added that two of the apostles having been sent into Armenia by Jesus, the king and his people were converted, but that their sufferings at the hands of powerful unbelieving neighbours caused all again to revert to paganism.

It was during the reign of Tiridates, as already noticed, that Christianity was firmly established by Gregory, "the Enlightener," the Armenians having since adhered to the faith with unparalleled tenacity, through every kind of persecution; their Church has never, at any period, swerved from its earliest principles, and alone has preserved the Nicene creed

* We are here referred to John xii., 20 22.

in its originality, with the addition of a simple form of prayer prescribed by Gregory. Representatives of the Church having failed to make their appearance at the Council of Chalcedon in the year 451, in consequence of the country being engaged in a desperate struggle with Persia, the partisans of Eutyches, whose doctrines were entirely condemned by the council, busied themselves spreading the report that the error of Nestorius had been revived at the council just held, which being believed by the Armenians, they unhesitatingly and for ever rejected its decrees. They also reject with horror the doctrine of the Nestorians, whereby Mary is termed the Mother of Christ, for they worship her as being the Mother of God—*Astvadzadzin*, that is to say, *Deipara*, the co-existence of two natures in the Saviour being at the same time admitted.

The first Christian church was erected at Etchmiadzin, in 309, by Gregory, the "Enlightener," the present cathedral, the mother church, being a restoration of the 15th century. In the adjoining monastery, founded in the sixth century, is the residence of the Catholicos, or primate, and of a certain number of archbishops, bishops, archimandrites, monks, and novices; also a treasury, in which are preserved the ecclesiastical vestments, mitres, and pastoral staffs of centuries, church plate, and relics that are considered unique. There are also the few remaining contents of what was once a renowned library, several printing presses, and a type foundry. The various buildings are enclosed within a high turreted wall, pierced by four gates that give access to the interior, presenting altogether the appearance of a fortress of the olden time.

The clergy is divided into black and white, the latter, called *Kapanè*, including officiating priests of various grades. A candidate for the priesthood must be a married man, but he may never take unto himself a second wife, nor may a priest's widow marry again. The black clergy, *Vartabed*, consists of monks, who alone are eligible for advancement to higher office, and are bound to celibacy. It would occupy much time to describe the various rites, but it may be mentioned that the sacraments are seven in number, viz., Baptism, Confirmation, the Eucharist, Penance, Ordination, Matrimony, and Extreme Unction, the eucharist being administered to the laity with unleavened bread and wine unmixed. Auricular confession is practised; relics of saints are devoutly guarded and employed; and although graven images are not under any circum-

stances tolerated, a picture of the Virgin and Child is to be found in every church with a lamp alight before it, "as though the Deity were ever in the dark," wrote Lactantius, when reproaching the Romans for lighting candles in front of their god! The intercession of saints is invoked, and prayers are recited for the souls of the dead without there being any belief in a state of purgatory, such services being held on Christmas-day, the seventh day of January, Easter Monday, on the anniversary of the day when Jesus appeared to His apostles, which falls in July, on the fifteenth day of August, being the ascension of the Virgin Mary, and on the seventeenth day of the same month, which is the anniversary of the finding of the holy cross.

One very strange anomaly is the still common custom of sacrificing animals in the accomplishment of vows. Thus, a patron saint is supplicated to intercede with the Almighty that certain sick be restored to health; that a journey be successfully made; that an enterprise be brought to a profitable termination; in fact for any temporal advantage, and a cock, a ram, a bull (the animal must be a male) is led near to the shrine of the saint, consecrated salt is put into its mouth, and it is then slain, and the carcase distributed amongst the poor.

There can be but little room for sympathy in considering the persistent observance of a multitude of superstitious traditional rites, completely at variance with what is learnt in the Holy Scriptures, since the Bible is preserved almost entirely as we have the privilege of enjoying it, except that in the Old Testament are several additional Books, esteemed canonical, whilst other Books, admittedly apocryphal, have been added to the New Testament. The Armenian version is pronounced to be the most faultless reproduction of the Bible*, and it was under this conviction that Lord Byron, who spent some time in the study of the language, commenced an English translation, but he never completed more than an Epistle to the Corinthians, one of the apocryphal editions. One truly primitive ordinance of the Church is to be fully appreciated, in the fact

* La Version Arménienne est, selon moi, la Reine de toutes les Versions du Nouveau Testament. L'avantage qu'a cette langue de pouvoir exprimer mot à mot les termes de l'Original, ne lui est commun avec aucune autre.....L'Antiquité de la Version Arménienne est indubitable. Les Historiens de cette Nation la rapportent au commencement du cinquième siècle, et leur autorité, qui n'est point à mépriser, est très-conforme à ce qu'on peut observer en comparant cette Version avec les plus anciens Exemplaires Grecs, qui nous restent.—Beausobre, *Nouv. Testament*, *Amst.*, 1718—quoted in Preface to Whiston Edition of *Moses Chorenensis*.

that the laity have a voice in the election of bishops, who, in their turn, are empowered to choose from among themselves a Catholicos, or Primate, the Emperor of Russia now approving the selection. Visitors to Etchmiadzin would surely be gratified at the unostentatious style of that dignitary, whose immediate subordinates are the Patriarchs of Sis, Aghtamar, one of the four islands of Lake Van, Constantinople, and Jerusalem. The late Catholicos, Gevork IV., was considered by all Gregorians to have sent an erudite and dignified refusal, when invited by Pius IX. to attend the Œcumenical Council in 1869-70.

It cannot be said that Armenians contemplate with indifference any secession from their Church to that of Rome, notwithstanding the general feeling of toleration. Of Roman Catholics there are about a quarter of a million, known as Franks. They are far more indulgent towards Christians opposed to Papal domination. There exist striking instances of this in the interment of Sir John Macdonald, British Envoy to Persia, close to the porch of the cathedral at Etchmiadzin, amongst those primates who were considered worthy of so distinguished sepulture; in the burial of many of our countrymen within the walls of the cathedral enclosure at Ispahan, in the Armenian cemetery at Kauboul, and so forth; and upon the occasion of the funeral of the lamented Henry Martyn, who died at Tokal, in 1812, when the ecclesiastical authorities attended with all the pomp due to a high dignitary. It was even decreed by the Catholicos Nerses (d. 1857), that services should for ever be held at the grave of Sir John Macdonald, by a bishop in canonicals, upon each of those days on which prayers are offered for the dead.

A matter of interest to most Britons is the progress in favour of Protestantism, due to the zeal and labours of American missionaries. According to late returns published by the "American Board of Commissioners for Foreign Missions" (1889), it appears that 73 churches in the Central and Eastern Turkey Missions were attended by 7,000 worshippers, that the average congregations at 180 different places where the Gospel is preached, amounted to upwards of 21,000 persons, and that there were no less than 14,215 children in regular attendance at Sunday classes; over 12,000 pupils were under instruction at 268 educational establishments, those students who graduated being sent out as preachers, until there are, at present—besides 23 ordained American labourers and 29 ladies—452 native

preachers, ordained and lay, and helpers, distributed over the provinces. But not only in Turkey are Armenians instructed by the light of the Gospel, for a large number of disciples are to be found at Shemahà in Transcaucasia; and when it is stated that Lutheran pastors have it all their own way in that city, where their evangelical labours are attended with success, the rulers of Russia and Turkey—with some exceptions, no doubt—are scarcely to be charged with intolerance towards *Christians outside the pale of the national religion* as is commonly laid to their charge. Other Protestants are at Djulpha, under the auspices of our Church Missionary Society, at Ouroumyeh, and elsewhere.

We pass over the Armenians in the Turkish Empire, their situation, under whatsoever aspect, being an every-day topic in the Press, to observe that, except for the undeveloped condition of its vast and precious resources, they are certainly far happier in all the relations of life, in Persia, than in either of the other two empires that share in the sovereignty over their land. They are largely privileged, enjoying, as they do, the most perfect religious freedom and the special protection of the Shah, who is wisely and generously solicitous of all Christians within his dominions, whilst carefully keeping himself aloof from their mutual jealousies; many hold high office, none pay taxes in towns, all are exempt from conscription, and in time of trouble they find safety in their imperial master, and places of refuge, if needs be, under the flags of the several foreign representatives—preferably under those of Great Britain and Russia.

The advantages held out by Russia are of a distinct kind, and access across the border being facile, there can be no difficulty in accounting for the increasing number of refugees from Turkey into the Christian Empire; but, be it noted that, as Christians fly from Turkish domination into Russia, so have Moslems, of late years, taken to decamping into Turkey, to avoid Russian rule, such exchange being certainly to the loss of Russia in the matter of numbers, but advantageous to her policy. In Russian Armenia, every village and hamlet is self-governed, each "elder" being elected by the inhabitants, who are also empowered to nominate rural judges for the investigation and settlement of trivial disputes—appointments that are valid for three years. There are national and government schools in which the Russian and Armenian tongues are taught, and a college with seminary, at Etchmiadzin,

that is entirely supported out of the revenues of the Church. Administration in Transcaucasia—as is the case in the Turkish capital—is largely conducted by Armenians, who hold office in the police and customs, as legal officials, medical officers, road surveyors, post and station-masters, &c., Georgians, Imeritians, and Mingrelians being very rarely employed in such capacities. They are to be found in most departments of the State, several distinguished soldiers having obtained a wide reputation in recent times, as, for instance, Shelkóvnikoff, Mourádoff, Lazariéff, Argoutinsky, Der Goukasoff, Béboutoff, and Loris Melikoff. Many Armenians are professors at universities, learned members of the legal profession, and bankers of repute.

Among the noted Armenians of the present day should be included Neriman Khan, Persian Envoy in Vienna; Hagop Pasha, late Minister of Finance; Vahan Effendi, Minister of Justice; and Artim Bey, Under Secretary for Foreign Affairs, all at Constantinople; Malcolm Khan, late Persian Envoy in London; Aïvazoffsky, the marine painter, with whose beautiful sea-pieces Englishmen have of late been made familiar; Dr. Alishan, Diratsoff, Dr. Issaverdens, Mahsoud Effendi, Manasse, Nubar Pasha, Sabouh Effendi, Ohannes Tchamitch, Vahan, the late Nicholas Emine, and many others.

In conversation one day with the late General Loris Melikoff, whose fall from power, deplored by every educated Russian, caused equally deep regret even to the amiable sovereign who was prevailed upon to decree the same, I referred to a feeling prevalent amongst Armenians in Russia, that, as a race, they were denied opportunities for advancement in the same way as afforded to orthodox subjects of the empire. "It is not so," replied the General, "I am an Armenian. At the age of twenty-nine I held the rank of colonel, and was commandant at Kars when that fortress was restored to Turkey, and you are aware of the position I have since attained." He then quoted some of the names recorded above, as proof that promotion was the guerdon equally of Armenians as of *bona-fide* Russians. "I am aware," I continued, "that a goodly number of Armenians have held and do hold high office in the service of Russia, but the complaint is to the effect that those so favoured are very few in proportion to the many subjects of that nationality." "Ah! mon Dieu! Je ne saurais vous dire; d'ailleurs je ne suis pas le gardien des Arméniens," was his Excellency's rejoinder.

Whilst some travellers unite in speaking of Armenians as enterprising, intelligent, and obliging, those of education being usually good linguists, others, perhaps on shorter acquaintance, decry them for their cringing, subservient, and altogether unmanly ways; but it is manifestly as unfair to estimate the national character by the miserable specimens met in bazaars, maidans, and at landing-places, as it would be to judge of Englishmen or Frenchmen on contemplation of the wretched touts and other loafers at English and French seaports. It is due to persistent industry, and consequent success in commercial pursuits, that a large proportion of the trade in Persia and Turkey is in their hands; also in South Russia, and the Caucasus where Nahitchewan on the Don, Tchaldir near Rostoff, Mosdok, Kislar, &c., are purely Armenian settlements. Tournefort, who spent some time amongst them, 150 years ago, wrote:—"The Armenians are the best people in the world, civil, polite, and full of good sense and probity. . . They trouble themselves with nothing but trade, which they follow with the utmost attention and application. They are not only masters of the trade in the Levant, but have a large share in that of the most considerable places in Europe. They come from the furthest parts of Persia to Leghorn. Not long since they settled at Marseilles. They travel into the dominions of the Mogul, to Siam, Java, the Philippine Islands, and throughout all the East, except China." Such words stand good in these our times as characteristic of the people. Armenians are ever unpopular in Turkey, being under the ban of an ancient saying that it takes two Greeks to outwit a Jew, and three Jews to outwit an Armenian; and in Russia they are assimilated to Jews because of their penuriousness and love of money, failings in which they by no means stand alone. There is no doubt that the Armenian of a certain class and calling will, like a true Oriental, take advantage of a stranger, and impose upon him if he can, in the same petty way as is practised at restaurants and hotels, and by cabbies, in very many European provincial towns.

Tournefort's amusing description of the Armenian's mode of effecting a purchase, is, in part, a common enough sight at the present day, especially in Turkish towns. "We could not but laugh," says the distinguished botanist, "to see the way of trafficking among the Armenians in the caravanseras of Erzeron. They begin by putting money on a table, as

among the Turks; after that they haggle a great while, and add one piece after another, but not without a great deal of noise. We believed, by their way of talking, they were ready to cut one another's throats, but they meant nothing like it. . . . The brokers squeeze the hands of the sellers so very hard, as to make them cry out, and don't let them go till they agree that the buyer shall not pay above so much; . . . after that, everyone laughs. They say, with reason, that the sight of the money makes them sooner agree.'

An Armenian nobleman observed to me one day, "My countrymen may be assimilated to the Jews, but they are wiser than they, and, therefore, superior to them; for the Armenians are sensible of the advantages of a good education, and they avail themselves of opportunities for having their children brought up in conformity with the exigencies of the times; whereas our Jew (this conversation took place in Russia) quite ignores the necessity for education.'

Russia is diligent just now in flooding Central Asia with her productions, it may be said with the aid of the bayonet, and we are informed by those who should know, that her manufactures are carried on by caravans from stations on the Transcaspian railway to Herat and Kauboul, in the face of the restrictions imposed by the Amir of Afghanistan; and largely to Meshed (200 miles only by road from Herat), in the fertile province of Khorasan, where Russian merchants are energetically seeking to extend their operations, and establish a still firmer footing. In the meantime, Englishmen will do well to bear in mind that Armenians, and none others, are eminently the patient, toiling, persevering colporteurs over the least known bye-paths and mountain passes in Asia Minor, in the Caucasus and Transcaucasia, in Persia, and in the vast border lands of those territories; petty traders without number, who would too readily give the preference to British over all other merchandise, because of their superiority and of their being appreciated by the masses, were any such available and within easy reach, say at depots established for the purpose by British enterprise, at certain frontier towns as commercial centres. The Armenian pedlar does not care to journey afar in search of the wares in which he deals, for it would not pay him to do so; but were his energetic spirit encouraged by the sight of a varied stock of British cottons, cutlery, &c., at the threshold of his boundless field of action,

British goods, thus at hand, would find their way by a short land route, legitimately and extensively, amongst the many populations that are as yet beyond the sphere of Russian domination. Apart from the honest colporteur is the contrabandist, indigenous in every land, who will dexterously introduce himself and his load to within the limits of Russian protectorates, in spite of sentinels, painted barriers, and protective enactments, too frequently with the connivance of those whose duty it is to circumvent and apprehend them. This he has been doing for years, on no small scale, as I happen to have myself discovered.

The value of the exports of British goods from the Punjab to countries beyond the frontier has declined from £1,268,485 in 1886-87 to £1,184,170 in 1888-89, a falling off perceptible in the north rather than on the Dera-jat frontier on the south, to be attributed to their enforced exclusion by Russia, but also in part to the taxation to which they are subject in Afghanistan. The frontier towns of the Punjab, viz., Dera Ghazi Khan, Dera Ismail Khan, Banna, Kohat, Peshawur where there is a small Armenian Colony, and the Hazara, are well supplied with dealers in spun cotton and cotton fabrics, and Punjab traders are full of enterprise in discovering outlets for their goods, but it is perhaps now time to add to these commercial depôts by others, say at Sukkur (Sind) and Sibi (Beloochistan on the Sind-Pishin railway), as well as at Quetta, some eighty or ninety miles only from Kila-Abdullah, just before reaching the Khojak tunnel and pass. From Quetta, Armenian colporteurs might be trusted to scatter supplies—entirely on their own account and paid for in ready money—over Beloochistan and beyond, thus supplementing the Persian trade from Bombay if we would not lose that trade, as well as in Afghanistan, and from Sukkur and Sibi they would travel amongst the tribes that are being brought more definitely under British influence, between the Sibi-Pishin railway, a material resource to them, and the Gomal and Kundar rivers. It is out of the question for European traders to attempt to reach Kandahar, Kauboul, or Herat, and especially British subjects, who are forbidden to cross the India frontier except with official permission; but Persian and other Armenians would undertake to do so from different points, after their own manner, peaceably and meekly, and confront Russian goods that were being introduced from the north*.

* I have not neglected to consult that able work, Ibbet-

It is idle to dwell here on the improved relations that should or might exist, as some think, with that British pensioner, the Amir of Afghanistan, and thereby question the wisdom and action of the Government of India, surely the ablest judges in such a matter; but it would certainly be a powerful support and incentive to the Armenian pedlar were the Amir to order that he was not to be molested or interfered with in his progress through his Highness's dominions. That this unique trader would find it to his interest to push the sale of British goods—apart from India-made cottons—may be assumed from the increasing demand for piece goods on the North-Western frontier, the imports thither having increased from 385,000 maunds* in 1881-82, to 503,000 maunds in 1888-89, that is to say, to upwards of 4,000 tons; thus showing that, outside the cost of transit from the sea-board, an appreciable margin remains for profit.

Native Armenian industry is necessarily limited under present conditions. Armenians are good copper and brass founders, expert gold and silversmiths, and clever mosaic workers in marble and vitreous paste, while their embroideries in gold, silver, and silk, which supply the principal bazaars throughout the East, are scarcely to be equalled. Silk produce is largely on the increase, the raw material for European markets passing through their own looms.

The habitations of the poorer classes invariably present a picture of very wretchedness. In the highlands they are constructed of mud or of stones, rudely put together, and of sufficient size to house cattle, whose droppings, made into cakes and sun-dried, afford excellent winter fuel—this in districts where timber is scarce. In the plains they are better housed, their dwellings—some are very spacious—with a court for cattle, standing within a walled enclosure. In the houses of well-to-do people, the visitor is shown into an apartment luxuriously carpeted, numerous chairs along the walls, and a table in the centre completing the furniture, beyond which room—it is called “the guest chamber”—no stranger is permitted to intrude. As a rule, the female members of a family keep effectively out of sight. It cannot be said, however, that this is the case everywhere, because in large towns, women are less reserved; but when

seen, their condition appears to be one of degradation, their humility and obsequiousness towards male relatives producing a most painful impression.

In describing the national costume, it may be safely asserted that the ladies of Armenia are not one whit behind their fair sisters elsewhere in the love of apparel. The head-dress consists of a deep coronet of velvet, embroidered in gold or silk, to which are attached gold coins, jewels, or other ornaments. It is the Georgian *thavsacravy*. The lower part of the face is often concealed by the *urpak*, much after the fashion of the Turkish *yashmak*, or by the folds of a large shawl that reaches from the crown of the head to below the waist, a practice that has continued since the time when females were forcibly abducted to supply Moslem harems, the people being driven to the necessity of observing the very custom of their oppressors in concealing the fairest of the sex. The gown is a long garment, from neck to ancles, of the gayest colours, profusely embroidered, over which is a tunic of silk or of satin brocade, having the skirt divided in three parts, the whole presenting as ungainly attire as it is possible to conceive. Linen incurs large expenditure, in consequence of costly trimmings in lace and embroidery. In early life, females are decidedly pretty, but they age comparatively early. Writing in the seventeenth century, Gemelli Carreri, a well-known Neapolitan traveller and explorer, wrote:—“Le donne Arмене sono bellissime, e la loro bellezza non è ajutata dal arte.” Men, likewise generally good featured, wear a high tapering hat of fur, and a loose frock coat having the sleeves split open to the shoulders, fitting over an under garment of black silk, tightened in at the waist by a belt that holds various weapons, frequently silver-mounted, and even jewelled.

This notice would scarcely be complete without reference to some of the every day customs in common life, from birth to death and burial, unshorn of their long traditional mystifications, and as still observed in more remote parts.

No sooner is a child born than it is rubbed all over the body with salt, and kept wrapped in a cloth until the arrival of the priest, who commences the service by consecrating water in which the midwife must bathe her hands and feet, and the infant is to be washed. Already, however, even before the priest makes his appearance, has the midwife drawn a line on the four walls of the room with an iron rod, to

son's “Census of the Punjab,” taken in 1881, but regret to say I have failed to discover what number of Armenians were in the Punjab at the period.

* One maund = 80 lbs.

keep out the devil and all his works, for the devil cannot break through iron. The child is baptised, by immersion, on the eighth day, having been carried to the church by the godfather or midwife; baptism is followed by confirmation, the infant's body being anointed in nine different parts, after which the little creature is wrapped in a piece of white cloth, and a twist of white and red silk is bound around the forehead, but more commonly around the neck, and sealed with an impression of the cross. The eucharist is next administered by the priest dipping his finger in the chalice and then putting it in the infant's mouth, so that three of the seven sacraments are celebrated at one time, viz., baptism, confirmation, and the eucharist. Upon returning the child to its mother, the godfather makes a present to the latter, in the presence of all friends assembled, and on the third day the silken threads and white cloth are consigned to the flames. On the fortieth day the mother is churchied.

Barrenness is a source of considerable distress, women under such circumstances being in the habit of making strange vows with the view of propitiating their patron saint. In more ordinary practice, they are to the effect that should the saint's intercession with the Almighty avail, the child's hair shall not be cut during the space of seven years; or, that it shall be continually clothed in white during a certain period; but the most disagreeable arrangement, so far as the desired for child is concerned, is its dedication to be for life the slave of its mother's patron saint. When this last vow is made, and the prayer is heard, a silver, copper, or iron ring—the expense incurred being according to the means of the parents—is fastened around the infant's neck with a padlock, there to be worn according to the terms of the promise, this ceremony being performed in front of the saint's shrine. At the expiration of the appointed time, the ring is removed and converted into a cross, candlestick, or some kind of ornament, and deposited at the shrine, after which the child becomes the slave of the saint, and is bound to make an offering annually to the church that encloses the said shrine, be it frankincense, candles, carpeting, or other useful gift.

In rural districts a boy learns to read and write, the Psalms and New Testament are put into his hands, he is taught grammar, takes a few lessons in book-keeping, and his education is considered complete. Lads destined

for the Church are specially trained by the clergy.

A curious custom is that of admitting a young man into a guild or corporation of artisans. On the completion of his son's apprenticeship, the father invites the masters of the craft to a feast, and when the toast of the day is about to be given, the candidate runs to the middle of the room and falls upon his knees. Approaching him, his own master inquires if he is persuaded that he can conscientiously call himself a master workman, and upon receiving a reply in the affirmative boxes the youth's ears three times, and from that moment the lad becomes entitled to have his name enrolled on the strength of the craft, and to set up in business on his own account, should he care to do so.

The education of girls is lamentably neglected, for they are rarely taught to read and write, unless as preparation for taking the veil. Convents, however, are very few in number. Housekeeping and the use of the needle are considered sufficient accomplishments for those who frequently become wives at thirteen, are mothers of five or six children by the time they are twenty, and grandmothers at thirty. It is a serious matter should a maiden attain her seventeenth year with no prospect of marriage, for so surely as the festival of St. Sergius comes round, she is obliged to fast three days and then eat salted fish, without the right to quench her thirst unless some kind swain be found who will promise to take her, and "be her master."

Young men also marry betimes, their acquisition of a wife being but too frequently an arrangement between the parents. In such cases, when a youth has attained his twentieth year, his parents select a wife for him, and employ the priest to carry the proposal to the parents of the young lady. Should the reply be favourable, a near relative—a sister or aunt—calls to see and converse with her; and if she is of opinion that the chosen one answers all expectations, physically and morally, she puts a ring on her finger, kisses her on the forehead, and the betrothal is complete, even though the girl may never have seen the man proposed to be her husband.

After the expiration of a few days, the youth, accompanied by his father, is taken by the priest to see his bride, perhaps for the first time, when he places a ring on the forefinger of her right hand; a supper follows, at which the good tidings are announced to the guests, and the bridegroom is afterwards conducted

into the women's apartments, taking with him fruit and sweetmeats as presents to his future female relatives. Upon returning to the guest chamber, he receives from his future father-in-law a watch, a belt, or other pledge, that will entitle him to ready access to the house, though he may never be left alone with his bride. These forms completed, the marriage is celebrated upon some convenient day, provided the following preliminary ordeals be undergone.

The bridegroom's male relatives and friends assemble, by invitation, at his father's house, where they find a tailor squatting cross-legged in the middle of the guest-chamber, with materials for making a suit of clothes. The company being seated, the tailor takes the youth's measure, marks out the cloth, and commences to cut it; but the scissors do not operate, nor will they do so, notwithstanding all his efforts, until each person present will have thrown him a coin, after which the wedding suit is proceeded with merrily. Next a barber is called in, and the bridegroom has to submit to being shaven. A few strokes are executed, but the razor does not pass over the customer's face, which exhibits, here and there, an unshaven patch, to the general amusement. Like the tailor, the barber is tipped, and the operation is completed.

On the evening fixed upon for the nuptials, the bridegroom, accompanied by his most intimate friends, bearing torches, repairs to the bride's house with presents in money and jewellery, carried on a tray, which he is allowed to offer to the bride so soon as she is prepared to receive them; and having accepted the gifts, her right hand is placed in his right hand, an act that becomes the signal for loud wailing and some weeping amongst the women, expressions of grief that are indescribable, the efforts to produce them being positively inhuman. Shortly, a procession is formed, and the bride, closely veiled from head to feet, mounts astride—the usual way in which women ride—a gaily caparisoned horse, and is conducted to the church by her male relatives, musicians at the head of the procession making sadly discordant noises. The complicated ceremony is concluded by the priest fastening around the necks of the bride and bridegroom separate twists of white and red silk thread, which he seals with an impression of the cross, as in baptism. From the church the nuptial party proceeds to the house at which the newly-married couple are to live, and as the bridegroom enters, he stamps upon and breaks a plate that has been placed on the

threshold, to signify that he is lord and master; but although these two persons have become man and wife, they are exhorted to keep apart from each other during three days and three nights, at the expiration of which time the priest visits them, removes the threads, and commends them for their chastity. The honeymoon tour, however, is being by degrees appreciated, and it not unfrequently happens, nowadays, that when his reverence calls upon the third day, he misses the young people, who have taken flight without waiting for his consent.

In many parts of Armenia, women allow several years to pass, after marriage, without speaking to a male, not excepting even their own father and grown-up brothers. Instances are of common occurrence, when sons take their wives to their father's house, where all live together, the eldest son becoming lord at the father's death, with the result that quite a large number of the members of one family are sometimes to be found under the same roof.

When a death occurs, the body is sewn up in calico, with the arms crossed over the breast, and on the second day borne to church in a shell, laid in the middle of the edifice for one night, and interred on the following, that is to say, the third day, sometimes without the shell. The new pall of black cloth becomes the perquisite of the officiating priest.

The death of a man of position involves his family in heavy expenses. A priest takes up his abode in the house of the deceased, for the space of one month, his duty consisting in offering up prayers for every person, be he friend or stranger, who, chancing to pass that way, enters the dwelling, such visitor being entitled to refreshments, which are prepared daily; and during the course of that month, the poor, sometimes amounting to hundreds, have to be treated to three substantial meals. Should a death be shortly succeeded by another death in the same family, the greatest uneasiness is experienced by the survivors, who, when ignorant and superstitious, will, if they can, cause the body of the first person buried to be surreptitiously exhumed, and his heart taken out—for they believe he must have quitted this world in a state of anxiety on account of his relatives, and they, in consequence, are rapidly following him to the grave!

Ancient cemeteries, in various parts of the country, present a remarkable appearance, the monuments being mostly in the form of a ram, or having a ram's head; and the in-

genuity displayed in the variety of crosses, sculptured in relief, is very striking. These tombstones are usually of a reddish sandstone, the finest works being of the 14th and 15th centuries.

Although priests take a prominent part, as has been shown, in the more important affairs of life, it is not easy to conceive the extent to which they are held in contempt. Many a man will retrace his steps homewards, and give up his avocations for the day, should a priest chance to be the first person he meets on his way to business. With but some few exceptions, priests, though tolerant, are ignorant and superstitious, but of sober habits and upright morals.

Superstition is common enough among the lower classes. A life-long protection against venomous reptiles is ensured by employing a snake-charmer to wind a snake around the child's neck. The howling of a house-dog forebodes a calamity. A murderer is easily discovered, for it suffices to boil the clothes of the victim, and the criminal cannot fail to give himself up immediately.

Petty larceny is condemned after the following manner. When any small object is missed, the inmates of the house in which the theft was committed, and suspected persons, are invited to meet together, when each in turn takes up a certain quantity of well-sifted earth prepared for the purpose, and carries it into a room, there to be thrown on the floor at a spot agreed upon beforehand. After everybody has passed through, the owner of the missing article turns over the pile of earth, and invariably finds what he supposed was lost.

Considerable difficulty is at all times experienced by statisticians in obtaining reliable returns of the number of Armenians in various parts of the globe, but most authorities appear to be agreed that it amounts to something like 5,000,000, of which total nearly half a million are settled in distant parts, there remaining scattered in their own land and in adjoining territories, all subject to foreign domination, a population that may well be entitled to respectful consideration, seeing it nearly equals those of the kingdoms of Portugal, and of Sweden and Norway, and exceeds that of the Netherlands, Denmark, Greece, Switzerland, and Bulgaria.

Some statesmen and *soi-disant* legislators of the day pretend to be greatly exercised as to the fortunes of the Armenians, but none move hand or foot to any purpose in behalf of that distracted people, beyond holding meetings, discussing the situation, and passing resolu-

tions. The integrity of Turkey must be maintained, says England, at all times, and none conversant with Eastern affairs will dispute the wisdom and absolute necessity of such a policy. Let us consider Asiatic Turkey under one aspect.

In the course of operations, five and thirty years ago, when Great Britain was expending blood and treasure, ostensibly in behalf of the integrity of Turkey, her warships landed on the shores of Transcaucasia an armed force that was to proceed to the relief of the gallant little band besieged at Kars; but before this aid had time to reach its destination, that fortress fell into the hands of Russia, to be restored shortly to Turkey at the bidding of the allies. Twenty-three years later, Kars is annexed to Russia. It may be taken for granted, no person will think it worth his while to doubt that the latest Russo-Turkish war, which cost Russia 850,000,000 roubles, was undertaken partly with the object of securing possession of troublesome Kars, as being a site of considerable strategical importance if in the hands of an enemy, and of Batoum for a harbour of refuge. Lord Beaconsfield appreciated the general situation when he undertook to hold the gates of the Dardanelles; his attitude saved the capital as it would have saved Batoum, and have profited Asiatic Christians, but for the twaddle of the "peace-at-any-price" mongers, and of numerous know-nothings—inside as well as outside the Houses of Legislature—and so the invaders turned sulkily homewards, but only when they found it inconvenient to stay. The next annexations to Russia, west of Ararat (we need not tarry long for them), will include Trebizond, and Erzeroum, Turkey's last stronghold against the encroachments of Russia; a city superbly situated for commercial purposes, and one of the only two trade routes to Persia as yet available for the transport of British goods. It is true, Alexander III. is a man of peace, as was his justly lamented father, yet, as the father was impelled to war by an "irresistible destiny,"* to wit, the influence of ambitious and unscrupulous ministers, supported by the clamour of a legion of armed men, so may the son be. "We must have Erzeroum and Trebizond," is the Russian soldier's cry, and such as claim to be loyal, or feign to be so, commonly add—"Do you not know

* The annexation of territories during the reign of Alexander II., commencing with the Treaty of Aigoun, May 16th, 1858, to Treaty of Berlin, 1878, exceeded those made under any monarch since Peter the Great.

that our Tsar must one day lead his troops to victory?"—and will then go on to explain that of the forty-four uniforms the Emperor is entitled to wear, there is one in which he refuses to appear, that of a Russian field-marshal, seeing that he has never had the opportunity afforded him for claiming right to the distinction. He will proudly assume the rank, they say, but only when it will have been conferred upon him by his own field-marshal, as honour gained after a glorious war. It is not the least likely that his Majesty has ever given expression to such sentiments, but the story is popular, nevertheless.

Now what would the possession by Russia of the two provinces, Trebizond and Erzeroum, mean? It would mean further annexation of the shores of the Black Sea, with splendid material for the rearing of seamen out of their Greek maritime population; it would mean the inevitable and immediate occupation of Van and Diarbekyr, and a tighter grasp around Persia; it would mean possession of the upper valley of the Euphrates, the control of inter-communication between Asia Minor and Syria, and command of the roads to a certain city at no great distance from Egypt. Humanely as the people of Russia shrink from war and further conquests, *for their views on these subjects differ most widely from those of their dictators*—and this is an opinion I feel entitled to express after a residence of upwards of four years in various parts of the empire—hearts would thrill with joy and pride were even the bloodiest of campaigns to bring them so near to the "holiest of places;" and what force would be able to resist the entire nation's pardonable arrogance? Are such things impossible?

What is the other view? If the integrity of Turkey is to be maintained, as has already been considered, Turkey will have to lend a hand by making a small, to save a greater, sacrifice, when the problem may possibly be solved. The plains of the Araxes are lost, doubtlessly for ever; but the Russo-Turkish frontier, according to the Treaty of Berlin, remains clearly defined. It is pretty nearly a "natural frontier," such as Russian rulers are everywhere in search of, in the form of an arc. The occupation by Russia of Trebizond and Erzeroum must obliterate that natural frontier, and lead to the enlargement of the arc, the subsequent extension of which, almost at pleasure, it will be impossible for any combination in the future to arrest, access to the banks of the Bosphorus being thus rendered

easy, and becoming simply a matter of time. Trebizond and Erzeroum are in greater peril, the more the Armenian's cry of despair resounds. The repeated representations, remonstrances, call them what we will, made at one time or the other during the past twelve years in behalf of the helpless, browbeaten Armenian subjects of Turkey, whether by her Majesty's ambassador, or by the representatives of other powers, having remained without beneficial results, it goes without saying either that his Majesty the Sultan, in whom is centred all authority, is culpable of the grossest negligence, or, what is more probable and nearer the truth, that Turkish administration is at fault through lack of means in money and competent administration. That the latter is the true state of the case, would appear to be indisputable, leaving no room for qualification, on examination of the numerous reports made by British consuls, and published periodically in the Blue books on Turkey. In the meantime the Armenian has to suffer, and he does suffer, whatever may be said to the contrary, and part of what he endures he himself illustrates by the following brilliant little parable, now a "household word."

One day an Armenian was employed by his *agha*, or master, to carry a very heavy burden, and his road lay up a hill and down on the opposite side; and as he laboured under the weight of it he prayed and said:—"Oh God! if thou would'st but lighten this burden just a little, I should be so happy, and go contentedly along!" But as he proceeded he passed a Turk, whose donkey, worked to death, had just dropped dead, and lay by the wayside. "Stop," shouted the Turk, "until I put my saddle and my packs across your back, for you must carry them since you are here." "Oh God!" cried the poor Armenian, "Thou did'st not understand me when I asked Thee to lighten my burden, for see, it is now made even heavier. But it is a Turk who wills it, and there are no means of escape."

Professor Vambery is reported to have stated quite recently, upon his return to Buda Pesth from a sojourn in the Turkish capital*, that autonomy could not be conceded to Armenia, if only because Armenia contains such a strong admixture of nationalities; that Armenian autonomy is the *mot d'ordre* of London revolutionaries; and that the mass of the people would be content with an improvement in the administration and a share in it, and with pro-

* The Times, October 22nd, 1890.

tection against the Kurds. The distinguished traveller is to be congratulated on having thus characterised the aspirations of the educated classes, by representing what they would truly prefer as being most to their interest, but it is precisely because their patience has been so painfully tried, and because their condition does not mend, that they are sighing for some form of self-government which will enable them to accomplish what their rulers fail to provide for, viz., their security against continued rapine, lust, and murder. As to autonomy being the *mot d'ordre*, specially, as implied, of London "revolutionaries," there is good cause, patent to all, why autonomy should not be the *mot d'ordre* of other such "revolutionaries" nearer home, and for the scarcely audible echoes thence, in response to the note so loudly sounded by their mouth-pieces in this our land of freedom, even though those "revolutionaries" constitute a nation.

The creation of a semi-independent Armenian state has been seriously suggested by others as well as by Armenians, on grounds which may thus be summarised :—1. That it would be the means of delivering several millions of souls from the terrible miseries consequent on misgovernment or from expatriation. 2. That being eminently an agricultural and trading race, intelligent and law-abiding, the new state would become a source, first of wealth, then of strength, to the suzerainty; and, I am disposed to add, 3. That suitable conformation of such a state would guarantee to the Sultan the integrity of his possessions in Asia Minor—at any rate, against invasion by land. Should, then, such a State be formed, certainly subject to Turkey, but under the rule of a Christian—a Bagration would be a suitable and rightful chief—the territory to be governed by him might consist of the province of Trebizond, of the eastern district of Sivas, the provinces of Erzeroum (including the plains of Alashguerd), of Van and Diarbekyr, these provinces to constitute the vice-royalty of Armenia, imperatively under the countenance of the Great Powers collectively. Russia's rulers would protest, as they are ever protesting against the exaltation of Bulgaria; but with the model of brave little Bulgaria before us, can the difficulties in the accomplishment of an independent Armenia be so very insuperable? I think we are at liberty to assume that the idea of a Protectorate is scarcely to be entertained, since no Power, with the exception of Russia, would care to incur so great responsibility, consider-

ing the geographical position of whatever might constitute the new State. Trebizond may not be Armenian, but if the integrity of Turkey is to be vindicated, the Armenian State must be made to extend from the shores of the Black Sea to the borders of Persia, its own new frontier being easily delineated, because defined by Nature itself over almost its entire length.

Starting from the mouth of the Yeshil Irmak, just east of Samsoun, we ascend that stream, pass along to the river Ghermilou, cross the eastern division of Sivas, until we reach the Euphrates, which river encloses Egyn, Kharpout, Diarbekyr, and Mardin, whence a straight line drawn across the Tigris and extended to the Persian boundary, will include the province of Van, the proverbial land of honey, and numberless places with names endeared to the people whose cause was being espoused. The rural population of the provinces above named, with the exception of Trebizond, has been reported, on reliable authority,* to be largely Armenian; whilst, in some towns, Mussulmans, Greeks, a few Syrians, and other aliens predominate; but none of these are likely in the end to embarrass Armenian government, because the former—that is to say, the Mussulmans—if continuing defiant of law and order, would speedily seek to eschew firm and properly supported Christian rule, *e.g.*, the exodus of Mohammedans out of Bulgaria during the past decade; and especially so would the marauding lawless Kurds, who would find ample room for disporting themselves to the west, to the south, or easterly, by joining hands with the Shahsovan, Yaghlavand, and Dilaghada Tatars, who are here, there, and everywhere, for mischief and looting as pastime, and who bear the palm as being the most accomplished of *katchagtchilar*, or smugglers, on the Russo-Turkish and Russo-Persian frontiers. The latter—viz., Greeks and other aliens, would find their occupation gone, so soon as their new masters, matchless traders, crowded home from elsewhere in Turkey, from Russia, Persia, and other parts of the globe. Whatever, however, the form of self-government conceded, the delegation of authority, adjustment of local claims, titles to property, &c., will not be without their great anxieties; and general security against disturbances and the bloodshed certain

* See "Collective Note," addressed to the Sublime Porte, dated Sept. 7th, 1880, and signed by the representatives of the Great Powers.

to ensue through animosity of races, would have to be ensured by a strong and lengthened military occupation of the territory about to be united under the new administration.

The Armenian is full well qualified to deal with Orientals, being one himself, and there are hundreds of men of European training who might be trusted to assist in the direction of affairs. His unalloyed nationalism, and his superior intelligence, have preserved to him an entirely distinct individuality, for while his Ottoman masters have been giving little enough heed to progress, except in the art of war by securing to themselves the most perfected engines of destruction, he has been eager in his endeavours to keep pace with western civilisation and its peaceful pursuits.

It has been strenuously advanced by those opposed to any form of self-government being conceded to the Armenian subjects of Turkey, that their number is much too disproportionate to justify any such solution of existing difficulties, an objection scarcely deserving of consideration, even were it based on any reliable general census of the population in Asiatic Turkey, since it must be admitted that the paucity, if any, is owing to the exodus of Armenians that has been progressing, slowly perhaps, but inevitably, during many years, and is still being pursued by those who, from well known causes, feel themselves constrained to such a course. Soon after the annexation of the Khanates of Erivan and Nahitchewan by the treaty of Turkmantchäi in 1828, the Armenians throughout Russia were estimated at 350,000, whereas recent statistics published by authority at Tiflis in 1889, admit the number to be 878,560, the Armenians themselves representing their population in that Empire as amounting to something like 1,250,000, and they are probably nearer the mark, seeing the very many towns throughout Russia, and her acquisitions in Central Asia, in which the nation is represented in greater or less degree. I have met them as commercial travellers even in Finland, as settlers in the Crimea and on the shores of Transcaucasia, and numerous as engaged in trade at St. Petersburg and Moscow, and in almost every city lying between the northern capital and the Persian and Turkish frontiers, as well as in towns on the banks of the Volga. The majority of those with whom I have from time to time conversed, were of opinion that the alacrity with which their fellow-countrymen would rally from all parts as one people, were any form of self-

government granted, would quickly tend towards the repopulation of the various provinces that have been reluctantly deserted at one time or the other by their kinsmen and forefathers.

There is a feeling prevalent that the Russian rulers would vigorously oppose any such settlement of the "Armenian Question." If they did so, it would look as if the conquest of Turkish territory, dating from the reign of Peter the Great, and pursued with marked intent during the last one hundred and twenty years, is to be persevered in with like determination so long as the onward path is not seriously obstructed. Russians of to-day feel they have to thank one minister at present in office—he is other than of native extraction—for the blessings of peace that have been preserved to them during some years, so that his removal, by resignation or otherwise, will have to be taken as a note of warning, and as an admonishment to those whom it may concern, to be on the watch. Meanwhile the Russian representative in Turkish Armenia, a military officer of rank attended by a suitable suite (consisting of scientific men), is engaged, openly enough, in a comprehensive survey of the territory under his jurisdiction, as a complement to the noble topographical model of Erzeroum and its surroundings ostentatiously exhibited in the Museum at Tiflis. The removal of the British officers who officiated as consuls in those parts would seem to be an impolitic act under existing circumstances. The far-seeing statesman, however, just now at the helm of British policy, may be credited with wise counsels in the course he has deliberately pursued in withdrawing them.

Most of the Great Powers regard Russia's extension with unconcern, so long as she does not contemplate making a meal of something to the west of her; but that she shall no longer vex any part of the Sultan's dominions, is, looking to the future, a matter for the timely consideration of Austria, France, Germany, and Italy, as well of Turkey and Great Britain.

DISCUSSION.

Mr. G. HAGOPIAN said he was astonished at the thoroughness with which Captain Telfer had studied this subject. He hardly thought there existed an Englishman who for so many years would watch the Armenian question and read up all the authorities upon it and the Armenian race, and the conditions now existing in their ancient Fatherland. Speaking as an Armenian, many of the things which had been

described that evening were familiar to him. He was born in Lesser Armenia, and lived there till he was eleven years old, but many of the things which had been described were common to Western and Eastern Armenia. In Western Armenia a little more progress had perhaps been made; among other things, the women were much better educated. In Sivas great progress had been made under the guidance of friends from America and England. Having had the pleasure of reading the reports in the Blue-book, he had been astonished to find that there were persons who saw and those who saw not. Among those who could use their eyes, and even pierce through the surface, was their worthy Chairman, Colonel Sir Charles Wilson, who had been during several years her Majesty's Consul-General at Sivas, and had sent to the Foreign-office some of the most interesting despatches on Armenia, as a reference to the Blue-books on Turkey would show. There were others who had said that in Armenia there are nothing but Kurds, and who held up the Kurds as heroes and men of valour, giving the second place to Armenians, but he was glad to see that, like Sir Charles Wilson, Captain Telfer had seen through these assertions, and discovered the latent power of the Armenian race. The conclusion to which Captain Telfer had brought them, after going very extensively into the history of the Armenian race and country, was a most happy one. The Armenians had no opposition to the Sultan; in fact, they wished to strengthen his empire. What they wanted was justice and equality under his rule, and not to be absorbed by another Power. They did not desire to ruin the future of their race, but wished to regenerate themselves; and they had appealed to the Powers to help them. Reforms had been promised, and Turkey had been made answerable for these reforms. For more than 12 years they had been waiting for the realisation of their hopes. Over and over again the Sultan had promised to carry out these reforms, but as yet nothing effective had been done. Had it not been for England, Turkey would have had a worse bargain with Russia than she had. The Armenians felt themselves quite able to administer the finances of their country, though the Turks thought that, by allowing the Armenians a voice in the administration of their native Fatherland, something terrible would happen to Turkey. The troubles of the Armenians had been many. History showed what the Armenians were in past ages, and what they had been able to accomplish. Although they had been promised protection by the Sultan, none of the firmans had yet been carried out in favour of his Armenian subjects. In Constantinople, Armenians were officially regarded on the same footing as the Mahommedans; but, the moment one went to the provinces, people seemed to be up in arms against the Christians. Their attitude was to exterminate the Christians—to drive them out of the country—and to weaken them by every possible means. He did not speak for the educated

and wealthy Armenians in Smyrna or Constantinople, where European influence was strong and powerful, but for the poor townsmen and peasants of Armenia. His countrymen had been impoverished; from year to year the owners of large flocks, lands, and moveable property, had been brought to ruin by the Kurds. When the Kurds attacked a village and carried off everything, it was soon known in London, and representations were at once made to the Turkish Government upon the subject, but restitution was a thing unheard of. That was why the position of the Armenians was becoming worse every day. An Armenian gentleman of eminence and culture at Constantinople had just declared to an English friend of his that there they were nothing but serfs, and dared not speak. Of course this state of things ought to be altered, and Captain Telfer had done great service in this direction by preparing the paper which he had heard with so much interest. With the appliances of science, he had also brought before their eyes Armenian homes, Armenian customs, and views of the churches; in fact, he had instructed him in a manner that he had never been instructed before by any lecturer. He hoped that other English gentlemen who took any interest in the Armenian race, would do something for the Armenians for humanity's sake as well as for the faith which all Christians profess. The Armenians did not wish to stop where they were; they wished to make progress. Although they might be sharp merchants, they were behind in the world's race, and the only means of giving them a fair chance was by allowing them to have an effective voice in the administration of their country, to make roads, to work mines, and to exploit the inexhaustible wealth of Armenia.

Mr. HYDE CLARKE said although the author had given a vast amount of information upon the subject, he thought he had hardly done justice to the scattered members of the Armenian race throughout the world. The Foreign and Colonial Section had devoted itself for many years to practical subjects, avoiding those of a political nature, but a considerable part of that evening's paper had been devoted to purely political questions, and as Mr. Hagopian had also dealt with these questions, he would, for the impartiality of the Section, and the character of the Society, just say a few words. In listening to the position of the Armenians in Turkey, he had doubted whether the paper really did refer to the political position of the people in Turkey, or whether it referred to their position in Persia or even in Russia. In Russia the Armenians were reported to have self-government, which they had not, but nothing had been said with regard to self-government of the Armenians in Turkey. The description given with regard to self-government of the Armenian villages and the Armenian populations in Russia applied expressly to Turkey, and with greater extensions still of the privileges of the

Armenian populations. As for saying anything on behalf of the Turks, that appeared to be a hopeless case in many places, because it was supposed it was a wrong thing to do justice to such a population. They might be charged with any kind of offence; they were charged with all the events of past history, and they were not allowed the excuses that were available for every other civilised population. They had been shown that evening, on the screen, an imaginary Armenia—an Armenia that had never existed in the past, and which, notwithstanding the eloquence of Mr. Hagopian, would not exist in the future. The country which was put down as Armenia, and which had been very well said did not consist exclusively of people of Armenian races, was very largely called Kurdistan. But what were they to do with the Kurds? They ought to have a paper upon the Kurds, and if an advocate of the Kurds were present he would as strongly abuse the Turks as Captain Telfer and Mr. Hagopian, because the Turks had most bitterly oppressed the Kurds. The Kurds had a great grievance against the Turks, and if their side of the question was heard, a different story might be given as to the unwillingness of the Turkish Government to carry out their duties towards the Armenian population. They had laboured very hard to restrain the Kurds; but they could not restrain absolutely a people who, from the time of the "Retreat of the Ten Thousand," as described by Xenophon, had always been a troublesome population. The only way the Kurds could be reduced to absolute tranquility was by exterminating them altogether, and that no Turkish Government will do. So long as Armenians and Kurds existed, they would commit offences against each other, and pilfer from each other's flocks. Everyone knew that the Armenians were not absolutely without blame. The imaginary Turk was supposed to be perfect, but he had the faults of humanity. The Armenian was known to be free from any spot, crime, or offence, yet there was hardly a week which passed in which they did not hear of some offence committed by Armenians upon the Armenians themselves. There was a good deal to be said on either side. There was something to be said by the Kurdish advocate and by the Armenian advocate, but nothing was to be allowed to the Turkish advocate. What he complained of was that the Armenians had, in many periods in their career, shown a want of political capacity to look after their own interests, and they were doing that now by sacrificing their nationality to the Russians. He merely made these remarks as a protest on behalf of the Society that they should not be committed to a political doctrine against their own interests, against the interests of England, and even the interests of the Armenians themselves. If looked at with a little care, the state which had been marked out by Captain Telfer would be found to be a great injury to the Arme-

nians, and a means of oppression to many populations, because it went down to Trebizond, where a number of Greeks were to be met with to be put under the dominion of Armenians, and the Kurdish population were to be made the serfs of the Armenians. With all that had been laid to the charge of the Turks, it must be borne in mind that the distinguished Armenians had a very large share not only of the government of their own population, but likewise in the government of Turkey. The Armenians of Turkey had a very large measure indeed of independence, but inasmuch as it was founded on the religious capacity, and not on the national capacity, it was very apt to be mistaken, but most certainly Mr. Hagopian knew that the community had self-governing institutions through the patriarchs and ecclesiastics, through the National Assembly, and the Gregorian community was represented in the Civil and Criminal Courts. The Roman Catholic Armenian community was represented, and even the small Protestant Armenian community had its self-government. All these points must be taken into account and carefully considered before arriving at any determination about the Armenia which had disappeared in the past, and that which it was not to be supposed would reappear in the future.

Mr. DELMAR MORGAN said that, not having been in Armenia, he was not in a position to speak authoritatively upon the very interesting and able paper communicated by Captain Telfer. He had, however, come across Armenian merchants in the trading centres of South-eastern Russia, particularly at Astrakhan, where a large number of them were engaged in trade, for which they showed a singular aptitude. Among the names of distinguished Armenians referred to by Captain Telfer, none could be spoken of with greater praise than that of Loris Melikoff, whose wise counsels at one time opened a future of great promise to Russia. Unfortunately, after the death of the late emperor, he was put aside. Among other Armenians of note was the late M. Patkanof, Professor of Armenian at the University of St. Petersburg. He could quite confirm what Captain Telfer said about the influence which Armenians once exercised on the tribes of the Caucasus. Looking at all the distinguished Armenians who had made their way in Russia, one could not but see that Russia did throw open its doors, and allowed Armenians to rise to positions of trust and importance; whereas the Turks and Persians had throughout history been their oppressors. Captain Telfer had referred to the diminution of English trade in Central Asia, owing to high transit duties in Afghanistan. This he thought was a fact of great importance, and reminded him of a project that had been started for making a railway by the Euphrates valley to India. He hoped that this scheme might now be revived.

The CHAIRMAN, in proposing a cordial vote of

thanks to Captain Telfer, said he was not aware that political discussion was entirely excluded from these meetings, or he should have asked Mr. Hagopian to somewhat curtail his speech. But as the question had been touched upon, he might say that, having lived among all classes of Armenians, it should not be forgotten that there were Armenians and Armenians. The mountaineer Armenian of Zeitûn and the Amanus Mountains was amongst the finest specimen of the Armenian race. When they got on to the table-land of Asia Minor, the Armenians lived to a very great extent in underground houses. There they were badly educated, and were very much on a level with the ordinary Turkish peasants of the country. When they came to the interior towns of Asia Minor, they found wealthy Armenian merchants, and, moreover, educated men. Armenian merchants were most enterprising. At Sivas, as in the Middle Ages, some of the great merchants would send their sons away with goods to Bokhara and Samarkand, and it would be two or three years before they returned with the produce. At Constantinople and the coast towns the Armenian gentlemen were very highly educated, and moreover they were most hospitable. With regard to the position of the Armenians in Turkey, he was quite certain his Majesty the Sultan was earnestly desirous of improving their welfare, but the Government of Turkey was such a complex one, and there were so many difficulties, especially in connection with a powerful neighbour, that it was almost impossible to carry out the ameliorations which the Sultan had at heart. They would realise the difficulty which Turkey had, when they had the same neighbour next door to them in India. One difficulty arose from the Turkish system of governing Christian communities. This was first introduced by Muhammad II., the conqueror of Constantinople, who found it very convenient to deal with the heads of the different religions at Constantinople. Everything was managed there through the patriarch, and in a minor degree it was the same thing in the provinces, where the bishop represented his people, and in smaller places it was the priest. That was a faulty system of government, and did not give the natural aspirations of the laity sufficient scope. With regard to the governing classes of Turkey, he might say that he had known several Turks intimately, and that many of them were men of great ability, desirous of doing what was right and to govern the people properly; but the fact was, the country had got into such a wretched state that the task of government was one of very great difficulty. The present government of Turkey, bad as it was in the provinces, was infinitely better than the government under the Byzantine Empire, which was the very worst in the world. The Turkish government had not always been bad, for, in the reign of Suleiman, there was a large stream of Christian immigrants into the country; and the country enjoyed good government at that time. As regarded the Turkish peasants, they were excellent people, quite as good as the Christian peasantry, and ready to live at

peace with their neighbours, if governed properly. The Turkish peasant suffered as much from bad government as the Christian peasant, being quite as much robbed and bullied as the Christian was, though, if it came to a question before the courts, and there was a conflict of testimony, the Christian would probably come off worst. With regard to the Kurdish question, he might say there had always been Kurds, and the Kurds and Armenians had always been fighting, according to history. The Kurds were mountaineers, pastoral and nomadic; they did not acknowledge one chief, but each chief had his own following in much the same way as the devoted clansmen in Scotland followed its leader. As one of the principal characteristics of an Armenian was pride of race, so the great characteristic of the Kurd was devotion to the clan. Unless there was a strong Government, he was afraid these troubles would always go on. One reason for the troubles was that Christians had for several years been allowed to hold land; and in a great many parts of the country, especially on the west coast of Asia Minor and in parts of Eastern Asia Minor, they were buying out the Moslems. In Western Asia Minor, districts that were full of Turkish villages fifty years ago, had now hardly one; the Greeks were gradually buying up all the land; and so in what is called Armenia the Christians had spread up the fertile valleys and bought up the land. That had created a feeling of unpleasantness amongst the Muhammadan inhabitants of that part of Asia Minor. As to the new plan which had been referred to for an Armenian province, he must characterise this as a dream, believing that it would never be realised. Another plan was this, to have a province on the basis of the Lebanon, governed by a man like the present ambassador in England, Rustem Pasha. Not a man now carried arms in the whole of the Lebanon, and places which thirty years ago were barren were now covered with villages. He believed it would be possible to organise one or two vilayets in Eastern Asia Minor in the same manner, but of course this plan was one which might be opposed by Turkey's strong neighbour.

The resolution having been passed,

Captain TELFER said that from deference to ancient history, he must dispute the statement that the Kurd territory went so far north as he had drawn his imaginary line, and he did not see why Armenians should be subject to Kurds a bit more than Kurds should be subject to Armenians. The chances were that if the Kurds became subject to Christian government, they would do exactly what the Moslems had been doing for the last ten years in Bulgaria, namely, clear out. The idea of the Lebanon was a splendid one, but there was no such powerful neighbour as Russia in the case of the Lebanon.

Miscellaneous.

COALFIELDS OF THE NORTHERN SHAN STATES.

A report from Dr. Noetling, the geological expert who has been dispatched from India to investigate the coal measures of the region between the Irrawaddy and the Salween, has recently been issued in Burmah. The result of the analyses of twelve samples of coal show a remarkable uniformity of composition. The highest per-centage of fixed carbon is 38·58, and the lowest 31·69. If the average of eleven analyses is taken, it is found that Shan coal has the following composition :—Volatile matter (including moisture), 55·40; fixed carbon, 34·94; ash, 9·67. The coal is, therefore, of poor quality, and can hardly be termed "coal." "Lignite," or "brown coal," would better express its composition. Shan coal, when fresh, would make good fuel, and, being rather hard, it will stand long transport. Those seams from which, owing to its friability, the coal could not be well transported, should make an excellent material for patent fuel. It is much poorer than the coal of the Southern Shan States. In the latter the per-centage of fixed carbon is from 64 to 70. So far, however, as is known, coal is not very plentiful in the Southern Shan States, while the seams in the Northern States are more favourably deposited, and, being found in workable quantities, they could be depended on for the supply of fuel to any railway through the Shan States. The fields examined by Dr. Noetling in the Northern Shan States were seven in number, the two chief ones being Laisho and Namma Manze. He does not think they will be of any value so long as there is no communication by which the coal can be easily brought down to the Irrawaddy. The coalfields are about 170 miles away from the nearest centre of traffic. The present road leading to them is only suited for carts for about 50 miles, after which pack animals must be employed. It is absolutely essential that a railway should be constructed if the coalfields of the Northern Shan States are to be of any economical value. But the construction of a railway line to this part of the country would be a costly undertaking if the fuel necessary to work it had to be transported from Rangoon. Moreover, the alluvial deposits in both the principal coalfields would form a serious obstacle to mining operations. The thick layer of clay in the Lashio field and the conglomerate in the Namma field, would make the sinking of a shaft difficult, as it would have to be constructed very substantially in order to resist the lateral pressure which it would have to stand in the alluvial deposits. Owing to the peculiar way in which the coal-bearing strata are found, a large quantity of water must be expected in both coalfields, and this would require

strong pumping machinery. Finally, the climate of these valleys is feverish, and the health of the miners would therefore be severely tried. It thus appears that coal-mining in the Northern Shan States is in the distant future; everything seems to be unfavourable to its development—no transport, difficulties of working, quantities of water, unhealthy districts, doubtful seams, and bad coal.—*The Times*.

Correspondence.

FAST AND FUGITIVE DYES.

In answer to the queries of Mr. Aumonier I may say that, although my experiments with colouring matters had reference only to their employment as dyes, still I feel sure that those colouring matters requiring the aid of mordants in dyeing, which proved to be fast for light on cotton, might also be successfully employed as pigments in paper-staining, *e.g.*, alizarin, cœrulein, resorcinol-green, &c., &c. With colouring matters of the class of "mordant-dyes," the character of the fibre or other material upon which they are fixed, seems to have less influence upon their fastness to light than in the case of the acid, basic, and Congo colours. So-called lakes are largely manufactured with the latter, and although many of them may be sufficiently permanent for wall-papers for internal decoration, they are certainly much more fugitive than the lakes made from the "mordant-dyes."

I do not know the exact character of the pigments containing arsenic, referred to by Mr. Aumonier, but my opinion is, that the presence of arsenic in ordinary pigments for paper-staining is altogether unnecessary, undesirable, and even dangerous; and I consider that the arsenic has not the slightest influence in rendering the colours faster to light. Certain it is, that the fast colours derived from coal-tar, of which I spoke, are non-arsenical; indeed, this is the case with practically the whole of the coal-tar colours now made. The only exceptions known to me are very low-class magentas and maroons, made from residues of magenta manufactured by the now almost obsolete arsenic-acid process.

Since 1839, the calico-printer has very largely employed arsenate of soda as a fixing agent for his iron and aluminium mordants, both in madder and alizarin dyeing, and, indeed, without any injurious effects. In these prints the arsenic is in a perfectly insoluble and innocuous form, and it does not rub off. On the other hand, arsenite of alumina has been largely employed by the calico-printer in the production of cheap, low-class, loose steam-styles; and, although the object has been to render the basic-colours somewhat faster to washing, the prints have been largely sold incompletely washed, or even not

at all. In these cases, I consider the arsenic to be in a highly dangerous condition; and it is, undoubtedly goods of this class which have given rise to the just complaints of the authorities of Norway and other countries. I need scarcely add that there are other methods of fixing basic colours upon calico without the use of arsenic.

J. J. HUMMEL.

Yorkshire College, Leeds,
May 26, 1891.

PERIAR IRRIGATION PROJECT.

I am very sorry that I was prevented, by my age and deafness, from being present at your meeting for consideration of the Periar project. I should be greatly obliged if you would allow me space in your *Journal* for a few remarks on it.

I see no reason to doubt that the present project will be of great use, and abundantly profitable, even to the Treasury, and, of course, many times as much so to the country. One of the unhappy circumstances of these Government projects is, that not a word is mentioned about the total money value of them; so that their execution is made to depend upon whether they will return 4 per cent. or 5 to the Treasury; while they would return probably ten times as much to the people. The water-rate on the river irrigations in Madras is 3 rupees per acre, while the increased produce alone is 30 rupees—besides the reduction of the cost of transit to something quite nominal—the entire regulation of the water, so as to free a much larger track from flood and other benefits, in all probability 200 per cent. on the outlay. It is a grievous mistake to leave this entirely out of all discussions on these improvements.

For the present project I entirely disapprove of the use of concrete for the dam, though it is now so extensively adopted. Surely it is a great mistake to go to a great expense in breaking masses of rock into small pieces that you may incur a still greater in putting it together again, when the dam might be constructed of any sized rough blocks, just as they are quarried, at one-tenth of the expense, and in one-tenth of the time. A lining of the inner slope with small stone and earth will make it water tight at a trifling cost.

The thousands of native tanks are formed by banks of earth at a very small cost, and they have stood for thousands of years, and in many situations like this they might be made still more cheaply of rough blocks of stone.

With respect to internal transit, I offer for consideration the fact that after spending millions on land transit works between Liverpool and Manchester, it has been stated that they are so complete a failure, after a trial of 60 years, as to make it necessary to spend £8,000,000 in 35 miles of water transit on the same line. If there is a body of men in the world who know what they are about, it certainly is the capitalists of Lancashire, and this is their decision on this question

of land or water transit, even in a trifling line of 35 miles. What must be the conclusion we come to for a country with lines of 1,000 and 2,000 miles of distance? Nothing can be more certain than that England, with its trifling distances, will be now provided with a complete system of steam-boat canals, and how much more are they required in India where at present it costs 1s. to bring a bushel of wheat to the coast, £2,000,000 a year for 1,000,000 tons, the interest of £60,000,000 at the present Government interest; when it could be carried for 1d. a bushel by water. And while in England they are paying £8,000,000 for the improvement of 35 miles, they would make a steamboat canal over 1,000 miles for £3,000,000 or £4,000,000.

I must also add a few words on the general subject of the improvement of India. Instead of the opening for water-works being not very numerous, my view is that India offers an absolutely unbounded field for such works. Mr. Wood spoke of one project, the Toombuddru reservoir, where work that would cost perhaps £100,000 would form a reservoir containing some 10,000 million cubic yards of water, and provide for the distribution of four times as much, as it would be continually supplied for seven months in the year, and this commanding the whole presidency. I doubt exceedingly whether the whole world affords another project equal to this. And so throughout India.

I have been acquainted with the country 70 years, and my conclusion is, that 100 millions might be expended on public works in it, with total returns of 50 cent. Of the Godavery waters, we distribute by canals about 6,000 million cubic yards in the year out of perhaps 200,000 millions. There is no reason why we should stop where we now are.

But public works for India include not only irrigation and navigation, but also railways, roads, bridges, harbours, &c., so that it is an unbounded field, and I would spend at least 50 millions a year on such works. And the vast increase of population, if there were no object in improving the condition of the present people, will compel us to open out this incomparable land which it has pleased God to commit to our care, and which has already resulted in such immeasurable benefits to 290 millions of people.

A. COTTON.

Dorking, May 23.

Notes on Books.

CATALOGUE OF THE SCIENCE LIBRARY IN THE SOUTH KENSINGTON MUSEUM. London (Eyre and Spottiswoode), 1891. 8vo.

This is the tenth edition of the science portion of the "Catalogue of the Educational Division of the South Kensington Museum," which was first issued in 1857. The origin of the library is traced to the

special exhibition of educational appliances, which was held in St. Martin's-hall in 1854, under the direction of the Society of Arts. At the close of this exhibition many of the exhibitors of books, school furniture, diagrams, &c., left their contributions at the disposal of the Society, and shortly afterwards they were handed over to the Science and Art Department. In 1857 the collection was displayed in the temporary iron buildings of the Museums at South Kensington. Considerable additions were made subsequently, and in 1876 a library of general literature which had been formed for the official use of the inspectors, &c., of the Committee of Council on Education, was removed to South Kensington. In 1882, after the re-organisation of the science teaching of the Department, it was determined to transfer to South Kensington, for the use of the professors and students of the Normal School of Science, from the library of the Museum of Practical Geology in Jermyn-street, all the books not required by the staff of the Geological Survey or by the Mining Class. It was found that the number of works in the library numbered 45,000; and in 1883 it was decided that the books relating to science in the Educational Library should be amalgamated with the books from Jermyn-street, and formed into a Science Library. The catalogue of this large library of scientific works is arranged in a classification of subjects with the authors' names in alphabetical order under each heading.

THE WEALTH AND PROGRESS OF NEW SOUTH WALES, 1889-90. By G.A. Coghlan. Sydney, 1890. 8vo.

This large volume of nearly nine hundred pages contains an historical sketch of the colony—from the time of Don Pedro Fernandez de Quiros, who is styled the Columbus of Australia, and who sailed in 1606 from Lima in Peru for the express purpose of discovering a southern continent—and a description of its physical characteristics. These chapters are followed by sections devoted to the subjects of mining, commerce and shipping, agriculture, &c. Population and vital statistics, finance, Government law and crime, instruction, science, and religion, are other departments which all come in for full treatment.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 1...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers', Westminster Town-hall, S.W., 7½ p.m. Mr. John Kerr, "Portable and Pioneer Rail ways."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. S. Rideal and Mr. W. E. Youle, "Gum Arabic and its Modern Substitutes." 2. Mr. J. W. Lovibond, "The Quantitative Analysis of Light and Colour, founded on the Tintometer Colour Scales."

TUESDAY, JUNE 2...Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Archer, "The Garrick Period of Stage History."

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Biblical Archaeology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. O. F. von Moellendorff, "The Land and Fresh-water Shells of Perak." 2. Dr. G. E. Dobson, "The Derivation and Distribution of the Insectivora of the New World."

WEDNESDAY, JUNE 3...Entomological, 11, Chandos-street, W., 7 p.m.

Archaeological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, JUNE 4...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Cresse-Potter, "Observations on the Diseases of the Cocoa-nut (*Cocos nucifera*, L)." 2. Dr. P. Herbert Carpenter, "Notes on some Arctic Comatula." 3. Dr. P. Herbert Carpenter, "Notes on some Crinoids from the Neighbourhood of Madeira."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. J. H. Gladstone, "Observations on the Molecular Refraction and Dispersion of Various Substances in Solution." 2. S. U. Pickering, "The Nature of Solution as elucidated by a Study of the Densities, Heat of Dissolution, and Freezing Points of Solutions of Calcium Chloride." 3. S. U. Pickering, "A Reply to a Recent Criticism of the Conclusions Drawn from a Study of Various Properties of Sulphuric Acid Solutions." 4. W. Pullinger, "On Volatile Platinum Compounds."

Society for the Encouragement of Fine Arts, 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. C. Mackenzie, "The Orchestra considered in connection with the Development of the Over-ture."

Archaeological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

FRIDAY, JUNE 5...United Service Inst., Whitehall-yard, 3 p.m. Col. E. T. Hutton, "The Mounted Infantry Question in its Relation to the Volunteer Force of Great Britain."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. St. George J. Mivart, "The Implications of Science."

Geologists' Association, University College, W.C., 8 p.m. 1. Messrs. H. W. Monckton and R. S. Herries, "Some Hill Gravels north of the Thames," and "The Geology of Nettlebed-hill, near Henley." 2. Mr. A. J. Jukes-Browne, "The Geology of Devizes, with remarks on the grouping of Cretaceous Deposits."

Philological, University College, W.C., 8 p.m. Rev. Prof. Skeat, "Miscellaneous English Etymologies."

Quekett Microscopical Club, 20, Hanover square, W.C., 8 p.m.

SATURDAY, JUNE 6...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. H. Church, "The Scientific Study of Decorative Colour."

Journal of the Society of Arts.

No. 2,011. VOL. XXXIX.

FRIDAY, JUNE 5, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Conversazione will take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday, June 17th.

The reception by the Attorney-General (Sir Richard Webster, M.P.), Chairman, and the Members of the Council of the Society, will be held from 9 to 10 p.m.

Promenade Concerts will be given by the Band of the Grenadier Guards in the North Court, and by the Band of the Scots Guards (weather permitting) in the Quadrangle of the Museum.

A Concert of Old English Music will be given in the Lecture Theatre under the direction of Mr. Arnold Dolmetsch. The instruments used will be those for which the music was originally written—viz, viols, lute, and harpsichord. The first part of the concert will commence at 9.30.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied at the usual refreshment buffets in the Central Corridor of the Museum.

As the accommodation for coats, &c., is very limited, members will greatly promote the general convenience by not bringing with them more wraps than are absolutely necessary.

Each member is entitled to a card for himself, which will not be transferable, and a card for a lady. The conditions under which the use of the Museum has been granted by the Science and Art Department do not permit the sale of tickets; Members will, therefore, not be able

to purchase additional tickets for their friends, as in recent years.

The Members' tickets are now in course of issue.

FOTHERGILL PRIZE.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire.

A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres or other places of public amusement.

In cases where the invention is in actual use, reference should be made to places where it could be inspected.

A full description of the Invention, accompanied by such drawings or models as are necessary for its elucidation, must be sent in on or before the 31st December, 1891, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding the Prize, in case there is nothing in their opinion deserving the award, or sufficiently complying with the conditions, sent in for competition.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 12, 1891: LEWIS F. DAY in the chair.

The paper read was—

GLASS-PAINTING.

By H. ARTHUR KENNEDY.

In speaking of the craft or art of glass-painting, I use the term "glass painting" in a wide and inclusive sense; I mean not only painting *on* glass, but, as it were, painting *in* glass, or *with* glass. I include in that term all the processes that go to make up a stained glass window.

I use the term painting, rather than any word implying design, because, in an art like this, that deals with a special material, having its own particular requirements, I believe that the developments of the art should rightly

spring from the conditions of the craft, so that the weak points of the material and its processes (for all materials and all merely human processes have their weak points) should not be in evidence; and so that all the special qualities and beauties of the material should be used and displayed in their fittest manner. And I use the term glass-painting, because I shall try to deal to-night, not so much with the history of stained glass—in itself an immense subject—or with the chemistry that underlies it—a subject on which I do not feel myself competent to speak—but with the theory and practical workings of the craft or art itself. And, to have done first with the more theoretical side of my subject, I will ask you to glance for a moment at the peculiar, the perhaps unique, position that glass-painting occupies amongst the other arts.

It is undoubtedly a very important, and, in its larger developments, a very impressive art. A great west window, with the warm afternoon sunlight shining through it, produces an effect upon one more like that of some lovely scene in nature, in the vividness of its beauty, than that of a work of man's making. No other art can even approach the power of its colour; the sheeny loveliness of textile fabrics, and the infinite modulations of tint of painting, are alike paled by its fulness. Painting has, indeed, an infinity of resources that the material under consideration cannot command; like the human voice in singing, it may induce a variety of emotions. But the emotional effects that stained glass is particularly fitted to produce, it compels, like a blare of trumpets, by its volume and intensity.

In its finest developments it seems to affect all sensitive natures; novelists are fond of alluding to it, vaguely, it is true, but as if it meant something to them; and we find such allusions in the works of writers very little affected by works of art in general. And yet, with all these qualities and this amount of interest in the completed work, there has always been a strange lack of recorded interest in the makers of it.

Painters and sculptors have been the chosen friends of princes, monarchs, and popes. Every one knows of the relations of Pericles and Pheidias, of Alexander and Apelles, of Michael Angelo and Julius II, of Velasquez and Philip IV. In the other arts the names of Benvenuto Cellini, the metal worker, and Palissy, the potter, are familiar words to many who have little interest in their several works. Architects, wood-carvers, medallists, the makers

of furniture and musical instruments, have all stepped beyond the mere honour-roll of their special crafts, and inscribed their names on the broader record of a world not specially interested in the arts.

But glass-painting has no such representatives. There are names connected with the art that the student of stained glass will doubtless remember, but none of the bearers of them has ever, even for a moment, appeared as a person in the least worthy of remembrance by the world outside of his workshop.

Now and again names of those famous in other walks of art have for a moment been connected with the art of glass painting—but such connection has been merely a temporary condescension, and, in many cases, the connection is of a shadowy consistency, as that of Albert Dürer with the Fairford windows, or of Giovanni da Udine with a window in the library in San Lorenzo at Florence, dated 1568, at which epoch Giovanni was gathered to his fathers.

Literature, though it takes notice of stained glass, cares nothing for the glass painter. Artists of all other kinds, and artificers as well, are favourite characters with the novelist; but the glass painter is almost unheard of in fiction. I have only once come across an allusion to him, and that is far from being a complimentary one. It is in "*Ivanhoe*," where Cedric and Athelstane are imprisoned in the Castle of Front de Bœuf. "I cannot," says Cedric, "look on that stained lattice without its awakening other reflections than those which concern the passing moment or its privations. When that window was wrought, my noble friend, our hardy fathers knew not the art of making glass, or of staining it. The pride of Wolfganger's father brought an artist from Normandy to adorn his hall with this new species of emblazonment, that breaks the golden light of God's blessed day into so many fantastic hues. The foreigner came here poor, beggarly, cringing, and subservient, ready to doff his cap to the meanest native of the household. He returned pampered and proud, to tell his rapacious countrymen of the wealth and the simplicity of the Saxon nobles."

It is sufficiently evident from this quotation that the occupation of the glass painter did not seem, to Sir Walter Scott at least, as one likely to be chosen by a person of any self-respect. And, considering this general though vague admiration for the material employed and the works produced in it, together with an entire lack of interest in or respect for

the artificer, we may suspect that the art of glass-painting lacks some *imprimatur* that has been bestowed upon the other arts.

It certainly lacks that which age bestows, being the youngest of the crafts. Whilst other arts, plastic and decorative, were perfectly developed more than two thousand years ago, the very beginnings of glass-painting can hardly be traced back for more than nine hundred years.

This being so, it is of course obvious that glass-painting had no place in that finest of all art periods that takes its name from Pericles.

At this period we may glance for a moment, as we shall have to consider it again whilst speaking of the glass of the Renaissance.

Between the year 480 B.C., when the Greeks strained their strength and courage to the highest pitch to repel the Persian invader, and the year 404, when the defeat of the Athenians at Ægospotamos threw Athens into the grasp of the Spartans, in a period of less than a century, nearly all the then existing arts were carried to a pitch of perfection that has only been since excelled by the very highest genius, and, in some examples, has never been subsequently excelled or even approached.

The Athenian sculpture in marble of that time remains unapproached and unsurpassable; and the metal-work, though the remains of it are scantier, was doubtless of equal perfection. Even in so late a development of classic art as that found at Pompeii, we find, in the very kitchen utensils, an amount of art hardly to be discovered on the tables of the princes and millionaires of to-day.

The drama of Athens remained, in nobility of thought and expression, unequalled until Shakespeare began to write. In the arts of architecture, of painting, of pottery, of dress, of furniture, and of jewellery, the Athenians of that day created types which have hardly ever been excelled, and many of which exist as unchallenged models to the present day.

Now this splendid period was put a sudden end to by the brutality of the Spartan conqueror. When Athens was in the grip of Lysander, it was seriously proposed to utterly destroy the city, and to sell the inhabitants into slavery. Fortunately for all succeeding generations, these barbarous counsels were not carried into effect. The beauties of the city were spared, though measureless humiliation was poured out on her military pride.

The conquered Athenians had to stand aside and see the long walls from the city to the

seaport of Piræus, the defence and boast of Athens, ruthlessly plucked down by the Spartan, whilst to the music of flutes light-limbed girls danced, deriding the departed glories of Athens. By that deed the Athenian heart was broken, the Athenian invention stricken dead. Subsequent generations of classical artists repeated the old formulæ, played the old tunes over again, recombined them, or added to them finish of detail, but they invented nothing. Praxiteles carried out the technique of his art to a greater degree of elaboration than it had gained before him; but it was no longer any more possible for a new Pheidias to arise than for a new Æschylus or a new Socrates.

What we owe to classic art then, we owe directly or indirectly to the Greek art of that period, and the debt is a greater one than is generally realized. Much of our architecture is confessedly modelled on or adapted from the Greek; very little of it is wholly unindebted to Greek examples in matter of detail. In shapes for our pottery, metal-work, and furniture, we recur perpetually to Greek types. In jewellery, in ladies' dresses and methods of doing their hair, we frequently recognise suggestions from the exquisite taste of the Athenians. Our masculine costume, I may say, in parenthesis, is sternly modern, and owes nothing whatever to classic example.

Now, glass-painting alone of the arts has no Greek types to recall, and the time when it struggled into existence was one distinguished by very different characteristics from those of the Periclean age. It was not a time when the philosopher taught peacefully in grove or portico; and when the sculptor was the chosen friend of the prince. It was a fierce, turbulent, hard-headed, and iron-fisted age; an age when the strong man armed had to keep his house, that his goods might be in peace, and they were in peace no longer than until a stronger than he came against him and them. It was an age of the gloomy fortress, the moat, and the drawbridge, of the heavy hauberk and the two-handed sword.

No arts, then, save the making of weapons or the wielding of them, were greatly admired; and such little-esteemed occupations had to take refuge either in the cloister or in insignificance. The personal artist, with a name, possessions, and a style of his own, was not much in evidence; such artistic life as there was tended towards the community of craftsmen who agreed upon a tradition.

Glass-painting, then, when it first came to be conscious—to be a real thing—was the

work rather of excellent craftsmen than of artists; and its distinguishing feature was a thorough comprehension, by those who produced it, of the material they worked with, and all its qualities: its pre-eminent quality of richness of colour always being allowed its right pre-eminence. In the design of early glass, when it is on an important scale, there is often something that is, to us, very impressive; but the impressiveness is not that which is produced by definite imaginative art. Of this, in early glass, there is almost none. But we are impressed, because the men who produced these works knew their technical business thoroughly, and because they viewed the subjects they represented with a deep religious reverence, and depicted them with a child-like directness of simplicity.

The history of glass-painting not being my subject to-night, I will, for the sake of simplicity of reference, divide the periods of glass which it is important to study into two—the Archaic and the Renaissance periods.

We have just glanced at the archaic period, which may be summarised as a period of craftsmen. By a change in the general scheme of things at the period of the Renaissance, the artist again came prominently upon the world's stage.

It was once again possible for an ambitious craftsman to aspire to express his individual personality, and to raise his head above those about him, without at once being hammered down by the higher ranks of society into subordination and uniformity. And the arts had not for long felt their own vitality, and the freedom of expansion allowed them under then-existing conditions, before they desired to study their great classical forerunners, and to assist their kinship with, and descent from them.

Epic verse claimed its descent from Homer, through Virgil. Dramatic poetry pointed to Euripides and Menander as its ancestors. Sculpture showed its Greek affinities by studying with reverence every scrap of classic marble that came within its ken. Even architecture, the one art that then towered high without classic support, began to assimilate Greek elements. The painters, such as their enthusiasm for the works of the great Greek period, though nought but unimportant scraps of classic painting remained to them, eagerly read the descriptions of masterpieces handed down by such writers as Lucian, and strove to re-embody them in their own manner.

And, in the midst of this serious making out

of venerable pedigrees by these great and important arts, suddenly there steps upon the scene the poor little foundling art of glass-painting—a mere Topsy of an art, that, between the Greek time and the Renaissance, had somehow “grewed” into existence.

What was to be done? The position of glass-painting was very painful, almost indecorous; by no stretch of imagination could an ancestry be made out for it, and the final solution to the situation was found by inducing the art of painting to adopt the fatherless art of glass-painting as a kind of poor relation.

Thus I think we may understand the situation of glass-painting with regard to the other arts; it has never had, like those of them that were handled by the Greeks, a great period, in which it was at once grand as imaginative art, and perfect as craftsmanship. It has had an archaic period, when it was excellent as craftsmanship, but, as art, impressive only because it was earnest and sincere; and a Renaissance period, when though as art, as painter's art, it was much finer, and frequently very fine indeed, it was not always as glass craftsmanship all that it might be—the painter sometimes condescending to his material rather than doing its qualities full justice.

So that, in studying old glass, if we want to learn from it all that is to be learned, we must not hope to find one perfect period as a model on which to found ourselves. We must study critically all the important periods, looking in the earlier glass chiefly for the craftsman-like determination that the colour shall be, not merely good, but as rich, as magnificent, and as impressive as is possible to the material, and in Renaissance glass for a treatment of subject both imaginative and appropriate to the material. Together with great general artistic skill, a fine sense of dignity and picturesqueness, and frequently a most just apprehension of the process of painting on glass.

I may here say that for practical study of the art of glass-painting as formerly practised, I know of no single building that gives such a variety of interesting examples as the chapel of King's College, Cambridge.

The fact that the most magnificent colour, and the most intellectual design are found in old glass to have culminated at different periods, is one of the reasons why there is today a considerable divergence of opinion as to the right treatment to be followed in stained glass. There have been, before our time, two different treatments, both fine, and each

containing good qualities that the other does not possess.

And another is that stained glass, in spite of its having great possibilities for imaginative figure design, and for a considerable measure of pictorial treatment and expression, does remain an essentially decorative art; that is to say, an art dealing with a material, beautiful in itself, whose qualities must be considered before all others, and to the end of the work must be carefully kept in mind.

Essentially decorative art, however elaborate, springs from processes that adorn its material. Given a strip of sheet gold, as material for bracelet or crown, the first effort in decoration is to hammer bosses on it, to give increased play of light and reflection, and, consequently, more beauty. The bosses may come in time to be grouped and shaped, until they represent warriors and chariots, or gods and goddesses; but the principle of enriching the metal is as obvious in the last as in the first development.

Art that is essentially decorative has a natural analogy with essential lyrical poetry. A form of versification once chosen, the necessary conditions of metre and rhyme become to the poet, as the qualities of his material to the artist, opportunities, not restrictions; not only opportunities for beauty of metre and rhyme, but for an emphasis on the utterance of his thoughts not attainable outside that form of verse. He is no poet who finds rhyme and metre hamper imagination; nor is he who is not inspired by the conditions of his material a decorator. From the exalted position assumed to-day by realistic painting, decorative art seems to run some risk of being shouldered into an altogether secondary and insignificant place. It can only be saved by its material, as poetry, by its lyrical qualities, from the assumptions of realistic prose. We must sing, and have fresh words to sing; and as a song may touch our hearts as nearly as a novel, we shall not care to think of it as on a lower artistic level than the stories we get from the circulating library. Less elaborately imitative of the details of reality it will certainly be, but there is room in it for as much of art, and, perhaps, in a more highly distilled form, for as much of nature too. And so with the adornment of our rooms, and the windows that we fill with colour in our churches, we should not, if we can help it, wish that, though different from, they should be intellectually beneath the pictures that we pay shillings to look at now and then.

Art, then, can express itself not only in the

completely flexible media that admit the so-called realism of representation, but in materials that impose their own limits. In art, as in life, there is nobility in, and compensation for, self-restraint, as well as for the wise acknowledgement of external restraining necessities. The actor, for instance, who reveals too soon the whole compass of his emotional resources, has lost his hold over us; the really impressive man showing us that only at the culminating instant, perhaps not the whole of it even then.

A happy incompleteness has qualities of its own; a rough sketch may denote character and expression so perfectly, that no realism could do other than dilute it. To seek the reason of this would carry us too far away from our present subject, but the fact is on the surface.

Many human interests cling close to the productions of the decorative arts of the home and fireside, which enshrine memories of happiness or sorrow, gratify innocent vanities, recall pleasant hospitalities, and teem with homely everyday associations. It is to their advantage, as well as to that of their possessors, if, beyond this, the art in them is of a vital and clear-speaking nature that is intelligible, not only after their death, as it were, to the connoisseur who entombs them in a collection, but during their lifetime to the people who possess and live with them. In this direction we have made great all-round progress in the last twenty-five years, having struggled pretty clear of the worst period of decoration that ever existed. A comparison of the furniture, curtains, carpets, and the like in general use now, with those of a quarter of a century ago, has been too often made to need repetition here, but one vital point in the change is well worth noting. People not only use better colours than they did, and more graceful furniture, but they appreciate them; taking real pleasure in the soft colours of their curtains and dress materials. The artistic revival has run its course, gained its nickname, been taken up by society, satirised, and dropped; but the preference for delicate colour over crude survives it, and remains a permanent possession. Not now, in the most out-of-the-way country place, do the least sophisticated natives walk to church clad in those ghastly aniline colours that once shocked the landscape, abashing the sober tints of nature.

The art of stained glass is not yet fully fortunate in speaking a language understood of the people. Indeed, "I don't understand stained glass," is the remark one most fre-

quently hears made about it, and this even from people of considerable appreciation for other forms of art. This comes home to one when one sees what pitiful stuff people of taste are content to have in the doors and windows of their own houses. The purplish birds on the yellow leaves within a circle of harsh red, the whole backed up by alternate oblongs of bad pink and green; how frequently one notices that work of art standing where it ought not! The builder inserts this and the like of it in the first instance, but the occupants suffer them to remain, not perhaps confident that they could find anything else so much more agreeable to their feelings as to warrant the expense of a change. It means, perhaps, that about even the highest development of the art, as usually practised, there still cling conventionalities of the parasitic or stifling sort; traditions that have arisen, that could only arise, in a period of bad art, and that have survived into a time of better things.

Wholesome conventionality, the acknowledgment of limits, and the determination to pull up well within them, is of the nature of a backbone to decorative art. Excellent, too, is healthy tradition. A man, or a school of men who have practised a craft right well, bequeath to their successors not a series of cast-iron rules and regulations but a common-sense recommendation: "On such and such lines our art can be successfully carried out; adhere to them, we advise you, and see your way very clearly before you try to disturb them. If new possibilities arise, they must be dealt with; but do not change the old order for less than sufficient cause." Without some such tradition, a craft may become experimental and amateurish, and its productions perplexing.

Let us, before going further, try and understand stained glass.

The germ of it lies, not in the wooden-framed sash-windows with which we are most familiar, but in lead-lattice, or, as it is perhaps most often called, casement. The simplest form of lattice consists of square or diamond-shaped panes of white glass of the same size, connected by "leads"—that is, by strips of that metal, with a groove on each side, into which the glass fits, the leads being joined by soldering at the corners, and the interstices filled in with cement corresponding to the putty in our sash-windows. From this simplest form of a lead-latticed window, the next step is the introduction of coloured glass. By this we get square or diamond-shaped panes alternately of white and colour, or of several tints

in succession—a series of arrangements being possible whilst we still cut our glass in panes of straight-lined shapes all of one size. More variety comes with the half-step from this to panes still rectilinear, but of different sizes and shapes; and we have made a stride when we have found out how to cut our glass into pieces with curved outlines. Our framing line of ductile lead is as ready to go round a circle as along a straight line, and now with curve-contoured forms of varied colour arranged in groups, we have already a handsome stained glass window of pattern.

The next move is a momentous one, and may have a word of preface. The best ornamentist of the present time* has acutely noticed that some simple pattern shapes, that have been assumed to imitate natural forms, are in reality dictated by the tool or material employed. When their resemblance to Nature struck the primitive artist, he did what he could to make it closer, but they arose at first independently. A single stroke of a full brush on paper, beginning with a point, spreading from that, and then ending with a sudden and more rounded diminution as the brush quits the paper, resembles the form of a leaf; the simplest combination of such touches suggests a leaf-cluster. Surround a large circle with a series of little ones, and you get a broad hint of a frequent flower type. So our window-maker, having advanced thus far, could not fail to be struck with hints of natural form in his pattern, and suddenly his brain took fire with the longing to complete the resemblance. This led to an application to transparent glass of the long-practised process of enamelling; lines and shadows were drawn on it with a material that, when fired at a sufficient heat, unites with the glass and becomes permanently fixed. The imitation of form seldom goes far in any art before the designer tries to imitate the most interesting of all forms: to take on him the God-like function of making man in his own image.

Glance with me, for a moment, at such a daring mediæval workman.

His studio is bare and rude, one of a little city of timber-built huts, nestling at the feet of a stately cathedral, that is as yet but partly built. Hammering, chiselling, and sawing are going on all about him with a rhythmic noisiness. In other sheds like his are being hewn out the solemn figures presently to stand beside the doorways or in the niches of the west frontage. High overhead, clinging to scanty

* "Every-day Art." By Lewis F. Day.

scaffolding, the carvers are shaping crocket and finial, are chipping the gargoyle into grotesque life, or enriching with ornament the niche to receive the statue. The dust from their chisels silts in through his unglazed window space. All about him is manufacture in the literal sense of the word—hand-work. There is no Art Department, for there is no department down to the laying of courses of the masonry, where art is not. Interested monks come on the scene from time to time, pause for a few moments to watch, then disappear. They cluster at stated hours in the completed choir, and the chanting of psalms in sonorous Latin may be heard among the other sounds, telling how the day wears. Sometimes the great of the earth come to see, and the chisels pause whilst their wielders gaze downwards at the grand seignor, who appears richer clad even than he is against the white background of dusty road and fresh-cut stone, and at a grey-haired, scarlet-robed church dignitary, followed by black-clad obsequious figures and clanking men-at-arms.

Our glass-painter's appliances are as simple and few as those of an Oriental weaver; he has no diamond to cut with, no pencils, no paper or tracing cloth for his cartoons and working drawings. A heavy wooden working-bench does, among other duties, that of drawing-paper. On it he sketches his designs with a piece of charred stick, and when they are to be used many times he goes over the line with the red-hot iron he uses to crack his glass with, and makes them ineffaceable. His bench is dotted over with holes left by the nails that hold glass and lead in their places as they are being soldered together. When he wants an unincumbered surface to draw upon, he borrows a carpenter's plane and makes one.

He is working now on a tall lancet window, the ground of which is designed to be filled with a mosaic of interlaced forms, whilst the broad border and a series of super-imposed circles are to be of rich colour in foliated pattern. The pieces of glass for the ground are already cut and painted, and lie piled in a rough box. In another are those for the border and several of the circles. The central round, which is to be of more emphasis than the others, remains to be done, and our workman is considering it. Why not, it flashes into his mind, a figure—a saint? The figure drawing of that time is simple, and he has learned its practice; why should not a saint be represented in glass as on a wall? Hurriedly he

effaces from the board the half-sketched pattern within the branded circle, and recommending his new venture to God and Saint Luke, he begins to design his figure, planning it out by outlining the shapes of the pieces of glass of which it will be composed. The head shall be painted on a piece of tawny pink glass, and as the background is to be of ruby-red, the drapery shall be of blue, cut in a good many pieces, for the sheets of glass at our artist's disposal are but little ones. Then the hand that holds the emblem, and the other on the bosom of the drapery, they again must be tawny and so must the feet be. The lining of the drapery, where it shows itself, may be a golden yellow. With tremulous and eager care he sketches the lines of face, finger, and foot, of fold and twist of drapery, and then roughly outlined within the scorched circle on his dinted bench lies before him the first figure cartoon for glass. He sees no reason why the saint should not be as successful as the foregoing foliated patterns; but this that he has begun upon is a new thing, and he is in anxious haste to test its success through the slow processes of the material. Bit by bit he shapes his glass, each piece being laid in its place on the scored bench, roughly cracked with a hot iron in the direction of the desired form, and finished by laboriously biting the edges away with pincers. This completed, with a dark pigment he traces on the glass, piece by piece, the lines and shadows of drapery and face; and then the glass is passed through a kiln, and the painting fused with it, pieces that require retouching and strengthening having to undergo a second firing. Finally, he cuts the bits of ruby glass that, unpainted, are to form a background to his saint, lays all the pieces, painted and plain, in their places within the circle, and the little picture is ready to be put together: to be *glazed*, to use the technical word. Not until this process is over, can he see the effect of his design; and, as we must wait for him, we may as well watch him at work; for it is an ingenious process, interesting to observe. He first selects and cuts to its approximate length the wide lead that is to surround the circle, and by hammering a series of nails just outside its circumference, as drawn on the bench, prevents it from exceeding its limits. Into the groove in this bounding lead are fitted the outermost pieces of the background; between each two is placed another slip of lead, rather narrower, to hold them together. As each piece of glass is put into its place, a smart tap

or two with the handle of the glazing-knife drives it well home into the grooves of the lead on each side of it, and a nail driven into the bench in front of it holds it in place until more lead and glass are added. So the work grows, each morsel of the glass is surrounded with strips of lead into whose grooves it is securely fitted; when the picture is as yet unfinished, there is a frontier of restraining nails, which are taken out to be replaced further on, until the completed work gradually fills the circle. That done, the external lead is brought tightly round, its ends are trimmed and exactly adjusted, and the whole secured by nails. Then every one of the numerous points of junction of lead with lead in the whole work is greased to make the fixing solder adhere, and the solder is melted on to it with a red-hot iron, linking the whole together. The nails that confine it are hurriedly drawn from the board, the work is turned over, and the soldering process repeated on the other side; then—moment of moments—our patient workman holds up the circle to the window of his little hovel, and feasts a critical yet approving eye on the first figure ever painted on glass. The window is fixed in its place, the interested monks gather and applaud; brother workers in other arts cluster and discuss; the great of the earth arrive, and the new attempt is explained to the seignor by dignified ecclesiastics, all finally smiling on the new discovery. So we bid our adventurous workman good-bye, having lingered so long with him, because the processes he employed have been, with slight modifications, in use from that time to this. Later, the possibility was realised of applying other enamel colours to glass, besides the brownish black line and shadow pigment. Owing to their brilliancy being inferior to that of colour made in the glass, only two of these have played an important part in the history of the material: a yellow stain, made from silver, and a reddish enamel, applied to white glass, to represent the flesh colour, no tint in the glass itself being quite satisfactory for this purpose, and the artist not being always content to make his heads and hands of white. There is one really perplexing element in stained glass that I will try and elucidate—that is, the use of what are called *accidental leads*. An artist friend said to me the other day, "I understand the lead lines going all round the outlines perfectly, but I am puzzled as to why they sometimes go across the design, when there seems no need for them." Suppose—to take an extreme instance—we had to cut

out the shape of an hour-glass. It might, perhaps, be done with great care; but the danger of its cracking at the waist in cutting would be enormous; and if that were got over, it would have new perils to go through as it cooled after being fired. Even when finished and fixed in its place it would still be in danger. There is a certain elasticity in the leaden framework of a window, none worth speaking of in the glass itself; if the wind blew hard against the window that contained our hour-glass, the lead about it would yield a little, and it, being unyielding and brittle, would snap at its weakest point. Foreseeing this, the artist arranges his leads so that instead of such weak places in his window there shall be flexible joints.

This, then, is what we have to grapple with in trying to understand stained glass. All the important colour is in the material itself; this is cut out and fitted together much like a dissected map, where the countries are of different tints. The modifications in the direction of shading are made with a grey or brownish tint, those of colour are merely the adding of a tone to represent flesh, and of a stain that shows yellow on white glass and produces a green when applied to blue. If we find anything unintelligible to us in modern stained glass that does not obviously spring from these necessities, we are justified in objecting to it.

I am convinced that the comparative indifference of the public to-day to glass-work indirectly results from the improper division of labour in its execution. The ordinary practice is that, having been designed by an artist who makes a small sketch in colour and full-sized cartoons, the most important work of all—that is, the choosing and painting the glass—is put into the hands of men who, though sometimes skilful workmen, are seldom artists. The scale of remuneration almost forbids that they should be, and, in nine cases out of ten, the glass painter is an unambitious drudge, or a smart youth who only means to paint glass until he can persuade some one to give him cartoons to draw. This system puts the artist at the wrong end of the work—that is, if there could be a right one—when he really should be with it all through.

To be quite satisfactory, stained glass should have its colours selected, and its painting executed by its designer; in this way it will have a unity of effect and a harmony of execution with invention not otherwise attainable.

Of this I am convinced by the opinions of many well qualified to pronounce on the subject, some indeed thinking as I do, in spite of their practice being opposite; by considerable personal experience, and perhaps chiefly by a study of the ins and outs of work done the other way. I have known artists designing for glass who not only did not care to see their work when executed, but who positively objected, knowing by experience that it would be a caricature of their intentions. Truly, with this method of dividing labour, the most satisfactory work is that where the design is least artistic. Given a dry and unfeeling cartoon, the trade glass-painter executes it with very fair accuracy. The strongest evidence producible against the usual system is to be gathered from the more artistic of its attempts. From works where the designing is good, and the glass-painting has a measure of artistic skill, and between the two is produced a transparent picture, well designed and schemed in colour. In the qualities, however, that are essential to the material—the jewel-like brilliancy, the crispness and translucency, and all those sparkling beauties that we admire in early and in all good glass—it is completely deficient. The fact being that a design for glass ought never to crystallise and become unchangeable until it reaches its material. The fit use of that material is all important, and the design should be kept, as it were, in solution, until the requirements of the glass are satisfied. This of course, is not possible where the artist who designs personally conducts his design no further than on to paper. He must leave it there, a thing fixed to be copied on glass without reference to the requirements of glass. Were the copier an artist, it is not easy for one such to modify the design of another; it is against the nature of things that a subordinate should ever be allowed to adapt the completed work of his superior.

An obvious instance of this is to be found in the continual misuse of white glass. The artist designs his white drapery as for any other material, with very little absolute light, and a half-tone covering at least seven-eighths of it; the glass painter cannot do other than follow this pattern, seven-eighths of the material are obscured with shading, and the bulk of that drapery is without any of the beauties peculiar to glass. Sparkle and silveriness are the qualities appropriate to white glass; without them it is absolutely uninteresting. It is not shade on the glass, or even

dark shade, that is objectionable; without some decided darks the white would not attain its brilliancy; it is the monotonous universal toning-down of white glass, to get it into harmony with other colour not designed in the right key for it. You must not “perdooce tone” in glass by the use of paint, you must get it in your material, or else go without it. If you design as well as paint, you will learn so to design it as to avoid the latter humiliation.

It is not that the men who do these things do not know, have not studied; it is that the art of inventing in glass must be built on the foundation of handling and painting it, and can no further be otherwise learned than can swimming on dry land.

Colour, then, is the first vital consideration in glass. Is there any other comparable to it? To answer this, we must go back for a moment to that primitive studio, and note the new element that was being introduced—the likeness of a man. For this new element brings rights of its own with it. The human figure may not be slighted in any material, but, as far as the material allows, must be as well represented as the art of the time can do it. If not it is better away; it is not essential to stained glass, for perfect glass may exist without it. It is an invited guest, and courtesy must make its feelings deferred to. It is an important guest, who, when he comes, must show courtesy as full as he receives, lest he be not re-invited. Is there, then, a point where either host or guest must concede, where, to speak without metaphor, the figure painted on glass, to gain its perfect expression, must destroy some of the qualities of the material? It is very usual to insist that this is so, and it is easy to point out instances in every school of glass-painting, since the 14th century, where brilliancy of material has been sacrificed to pictorial considerations. Sir Joshua Reynolds's figures in New College Chapel, Oxford, are a typical instance; in them we have beautiful figure-work, and none of the beauties of the glass itself at all. But there is a reason for all these lapses that is clear enough; it is that the artist, or the school of artists, has been summoned to paint glass too late. A man who has formed his habits in a material that admits of his making his shadows as interesting as his lights, will overshadow your glass for you to the end of his days.

To do good glass an artist should not only design and paint it, he should steep his imagination in it, and get to know it, with its possibilities, so thoroughly, that when he conceives

a design, he conceives it in certain pieces of glass that he can put his fingers on. These will be in his mind through all the processes of his work. He will not arrange a piece of drapery, whilst making his studies, without thinking of the precise amount of shadow necessary to bring out all the excellencies of the material he will execute it on, and of the quality of shading, whether rich and trenchant, or crisp and filmy. He will select the raw material for his work with anxious care, choosing from each sheet of glass he uses just such parts as are most beautiful and most fit. The drawings, being his own work, and of the nature of studies rather than rigidly finished designs, he can, as he paints his glass, adapt them to the necessities of the material. The whole process being at his fingers' end, he can, in some places, leave the work on the glass to the inspiration of the material itself.

Stained glass, as an art that by such means is trying to attain a fresher mode of thinking, and a nearer relation to nature and the feelings of its own time, looks rather for sympathy to the public than to workers in other arts. Neither the architectural side of art, nor the realistic, look with enthusiasm at possible departures in this way. As a rule, the architect has been fairly satisfied with the kind of trade glass that can be turned out to order, in the style of any century required. To him its shortcomings are atoned for by its respectfully subordinate position; accustomed to this, he naturally is not particularly anxious for work of less tractability, which may have a will of its own to be considered and even consulted.

The realistic artist has no interest in stained glass except as a background, when he usually paints it incorrectly. Satisfied that the school of to-day has attained the one complete method of representing nature, he troubles his head not at all about the representation of her in any way to him less complete. And yet the very term realistic is a folly, if one compares the ocean of complicated fact, and the teaspoon in which it has to be contained, to produce realism. The most accurate historian tells not a tithe of the whole truth: the most inveterate romancer is not without a leaven of veracity.

Realist and decorator, though their attitudes differ, alike buy their stock-in-trade at the shop of that great universal provider, Nature.

The painter, in whose works design plays a subordinate part, presents himself at nature's counter, put his money down and says, "I want you to give me the best value in goods

for that, I am not particular as to what they are." Nature treats such a customer liberally, and because he is so accommodating as to take what is given him, he gets very good measure, and the transaction is a rapid and simple one, satisfactory to both parties.

But, when the designer presents himself, Nature knits her brows at the sight of him—she has had so much trouble already with him. For he does not come to buy anything she wants to sell, but is provided with a list of troublesome requirements, and will have those and those only—a head with such an expression on it, such a cast of drapery of such a tint and no other, or such an effect of rock or storm-cloud, or tempest-tossed sea. Nature rummages her shelves, and article after article is rejected, while the exasperating customer declares that he has seen just the thing he wants in that very shop before. There has never been such a piece of goods in the trade Nature at last declares; it could not be turned out at any price; the gentleman must have dreamt it. The gentleman admits that he may have dreamt it, but is none the less anxious that it should be procured for him. In fine, when bargaining is over, the parties separate grumbling, and the designer goes home with his purchases thinking he has spent a lot of money on them, and that, after all, his brain-children will have to accommodate themselves to circumstances, and put up with some rather tight fits in respect of the raiment he has been buying to clothe them with.

Selection of the fittest subjects for decorative art is never a very easy matter; in stained glass it particularly requires careful consideration. There are two ways of making the choice: one that the subject should be settled upon by the artist, the patron naturally retaining a right of veto; the other that it should be fixed by the patron, the artist being privileged to object to a subject not suitable to the work in hand. From some points of view the first way has advantages, but hardly to be set against the great additional interest to the possessor of the work if he is attached to it by associations connected with the subject, or even with such details as floral ornamentation or choice of predominating colour. It is a frequent misfortune that the all-pervading middle-man imposes a subject that is neither of special interest to the future possessor nor artistically fit.

In choosing subjects for a church window it is well to remember that, whilst many of the

most sacred have been so often treated in art that their representation can be little more than a modification of what has gone before, there yet remains in the Bible a mine of almost unused themes for this art.

The stirring history of Gideon is full of subject-matter, from his first call by the angel as he threshed wheat by the wine-press to hide it from the Midianites, to his crowning victory over the high-souled and courtly-spoken princes, Zebah and Zalmunna, who had ornaments like the moon upon their camels' necks. The other pair of princes in the same story, Oreb and Zeeb—the raven and the wolf—are picturesque figures; but the incident that presents itself to me most vividly is Gideon's interview with the inhospitable men of Penueel. They refused with a bitter jest to give bread to his wearied three hundred, and Gideon answered them, "When I come again in peace, I will break down this tower." One sees the fortress and the gesture against it of the man faint with pursuing, but God-befriended and certain of final victory. Fascinating, too, from this point of view, is that chivalrous foray of Jonathan and his squire, when they clambered up the toothed crags and fought the Philistine garrison during the earthquake, surveyed from the distance by the watchmen of King Saul in Gibeah. And a grand subject, of which I have seen no representation, is to be found in a verse of the second Book of Kings:—"And Elisha prayed and said, 'Lord I pray Thee open his eyes that he may see.' And the Lord opened the eyes of the young man, and he saw; and behold the mountain was full of horses and chariots of fire round about Elisha" (2 Kings vii. 17).

Indeed, for the representation of visionary subjects, of which we find so many splendid examples in the prophets and the Apocalypse, stained glass, with its strength and mystery of colour, is particularly fitted.

In subjects for domestic glass, though the individual spaces to fill are usually smaller, the range is quite infinite, for lighter and even humorous themes may be appropriate here. What a pretty window, for example, one might make with playing cards as a theme. The borders might be decorated with hearts, diamonds, and the like, with royal and knavish personages in the central groups. Where a consecutive series is required, the well-known fairy stories and the "Arabian Nights" are almost inexhaustible to draw upon. Some of the "Idylls of the King" are full of subjects,

"Gareth and Lynette" being particularly rich in the symbolism and colour suggestion, so treatable in our material. Indeed, besides his other gifts, the Laureate has a splendid feeling for essentially decorative art, a description in one of the "Idylls" being the best design by a poet that I have met with. It was treated in four bands of sculpture; and the subjects seem to suggest the style of the Pisani—

"And four great zones of sculpture, set betwixt
With many a mystic symbol, gird the hall:
And in the lowest beasts are slaying men;
And in the second men are slaying beasts;
And on the third are warriors, perfect men;
And on the fourth are men with growing wings."

The symbolism is perfect, and the succession of subjects very decorative, the wings of the uppermost figures forming a natural decoration to the top of the work.

With regard to the process of painting on glass, there is one general principle to be kept in mind, with which, as far as I have been able to study their work in detail, and close at hand, I believe the best of the old glass-painters to have been fully possessed; and that is that, when painting on glass, we are drawing in light upon dark; and that the shapes of the lights, not those of the shadows, are to be considered.

This is merely the carrying into detail of a *dictum* of Mr. Ruskin, who says, in "The Seven Lamps of Architecture" that Gothic windows were right in principle just so long as the forms of the openings, that is, the lights, were considered instead of the intervening spaces or mullions.

The windows are, one may say, shapes of light painted on a dark ground; and it is quite in harmony with this principle that the coloured filling of the windows should be regarded from the same point of view.

If we look at a rich-coloured, stained-glass window we shall realise that the bars that support it, the leads that connect its numerous pieces, and the darkest shadows are of the same tone as the walls that surround it. All portions left, of the dark background, on which the window is drawn in coloured light.

Old glass painters continually affirmed this principle by the constant use they made of the process of picking out lights. They were very fond of covering a piece of glass with a film of paint, sometimes completely opaque, and then, with a point, drawing on that ground in light, and very beautiful results they produced by this means. Indeed the line picked out in light is the typical process of

glass-painting. This principle is very frequently lost sight of at the present day; and a good deal of the hard wiriness that characterises modern drawing on glass is the result of its neglect.

In a piece of old German glass representing an enthroned pope, which, being in my own possession, I have had time to study minutely, I have found many interesting examples of how thoroughly the painter kept in his head that he was drawing with light on a background of darkness.

The ground of the picture behind the figure is on blue glass. The blue is a rather cold colour, and, if much of it were shown, would be slightly unpleasant. So the glass painter has covered it all over with quite opaque paint, and then out of this he has picked with a point a very freely drawn pattern. Against this background, which has so much strong black in it, is relieved the nimbus that surrounds the pope's head. This, which is on white glass, stained a soft yellow, is very delicately ornamented with pattern and inscription. There is not an atom of black upon it, it has been covered all over with a delicate film, out of which the inscription requesting the saint to pray for us, and the pattern work, has been daintily picked with a point, the glass painter being well aware that in order to give full relief to a line of light it is not necessary to darken the surrounding glass more than a single tone. His avoidance of hard and wiry lines of black is equally evident. Where black outlines are required, instead of fixing them by firing before putting on his shadows, the latter are laid straight over the lines, which are in consequence partly melted into them. And, in picking out the lights, he has frequently broken the dark outline, and on the light side of things sometimes done away with it altogether. Where he takes out a light on the shadowed side of his figure that also is pricked out right down to the clear glass, and is completely transparent. Its subordination to stronger lights being kept simply by lightness of touch, and delicacy of execution. The whole piece of work in consequence sparkles with light, and, though there is no lack in it of rich blacks, it fully retains the transparency appropriate to glass-painting.

In concluding this incomplete and discursive sketch of a very interesting craft, not fully valued, it may be, at the present day, I may note one point of interest to those likely to be practically concerned with it. Whilst many of the arts have reached their culmina-

tion long ago, and little remains to be done in them save not to be unworthy of the great work that has gone before, the same cannot be said of the younger art of glass-painting. We can hope for that at least a future that shall outdo its past.

DISCUSSION.

MR. WYATT PAPWORTH said he had listened to the paper with very great pleasure, but had been rather puzzled as to what kind of glass-painting Mr. Kennedy would have them carry out—whether it was glass-painting in geometric pattern or in figure subjects. He rather thought that figure subjects were meant. As the window by Sir Joshua Reynolds in New College had been referred to, he might state that he had always understood it was put forward as the vilest specimen of painted glass that existed. It would not be desirable to see Barry's pictures represented as stained glass windows, but yet Sir Joshua Reynolds's work was the same. The objection also applied to a large number of glass windows in various cathedrals. Glass which had a large amount of architecture in it was scouted on account of such work not being transparent, and so were figures also. In former days, the so-called white glass had a green tinge, and on it foliage was drawn, with brown markings, and formed into pattern. The finest examples of this work were the wonderful Five Sisters at York Cathedral—wonderful for their size as well as for mass of colour—which dated in the 12th century. These were of small geometric pattern the glass filled with foliage, with gems of subjects. There were also some excellent examples at Salisbury. Upon the question of emotion, he might say that no stained-glass window had ever produced any emotion or similar feeling in him. Either Sir Walter Scott or the poet Gray was the culprit with regard to stained-glass producing emotion. Another fine window was the west window of Gloucester Cathedral, from its being filled with coats of arms. In that line there was an immense field for the glass-painter. There was certainly nothing emotional in the windows at King's College Chapel; they were grey and dirty-white, with brown foliage. He wished to have heard more of the difference of the varieties of stained and painted glass, and also what was termed "flashed-glass." In respect of the painted glass of Sir Joshua Reynolds, he was old enough to remember a large stained-glass window, entitled the "Field of the Cloth of Gold," which was painted by Thomas Wilmshurst, and exhibited where the Oxford Music-hall now stands; that was simply painting on glass; and it required a strong light behind it to show it off, which was the cause of its destruction by fire after a few days' exhibition. Stained glass could not be used with any effect in highly decorated rooms. One notable example of this might be seen in the House of Lords, where the

windows had a large amount of stained glass, and, to Mr. Maclise's horror, his pictures were injured by the colours of the glass being thrown upon them. He should not condemn the little things which were sent out from tradesmen's shops for door panels and the like, because they really tended to the love of art if not to the encouragement of it. Moreover, such glass was comparatively cheap, and, in his opinion, was much preferable to the enamelled glass.

Mr. HAMILTON JACKSON said that Mr. Wyatt Papworth had asked for information about the various sorts of glass used in a "stained" glass window, and that he might as well supply that information. There was, first, the glass which was coloured throughout its substance known as "pot-metal." Secondly, "flashed" glass, which was a thin film of a powerful colour spread over a body of glass of a paler colour, which might be greenish, yellowish, bluish, &c., modifying the stronger colour attached to it; and, thirdly, that modification of the glass obtained by the application of the silver stain, to which, properly speaking, the term "stained glass" should be limited—the yellow stain so familiar in 15th century glass. Mr. Kennedy had treated the subject not only from the point of view of the craftsman, but from that of a poet, and his illustrations were very happy, particularly that of the artist going to Nature's shop to seek for goods to assist him in his work. It was not only that Nature seemed to take a delight in throwing obstacles in the way of the decorative man, who knew what he wanted, but that when he took the poor things he had bought home to his dream children, he found that they were not things quite suited to them, and that, in fact, they did not properly cover them, and perhaps that nudity was one thing which made people frequently take objection to decorative painting. He wished to say one word on the subject of the work being entirely executed by the man who designed it. There was no doubt that the designer and executant should be in the closest relation, but he could not see why the mechanical part of the execution should not be done by a man whose time was of less value; for one had to look at these things more or less from a commercial point of view. It was impossible to say to a client who required a certain space filled for a certain price, that he must pay more, or he cannot have good work. He would simply go elsewhere, and you lose the chance of doing the work. The only way was to make the design, and draw the cartoons, to consider the colouring and arrange, in company with the workman, what pieces of glass were to be used in each part of the window, and then leave him to execute the work, supervising it at proper intervals, and, if necessary, working on the glass. By this means, one was able to put in a window which should be a credit to one's self and an ornament to the building, for a low price without absolute loss.

Mr. H. B. WHEATLEY said the interesting point which Mr. Kennedy made as to the importance of the designer remembering that he is drawing in light upon dark, might be illustrated in the case of the first use of gilding on cloth for books. He possessed an early example of a black cloth cover with the design and its shading in gold. The designer had designed on white paper with a pencil, and when his shading came to be worked out in gold, the gold being lighter than the cloth, it was entirely wrong. In such a case to get the proper effect it was well to draw white upon a dark ground. In saying that Sir Walter Scott did not appreciate the work of the glass painter, Mr. Kennedy seemed to forget that Scott was writing as a dramatist when he made Cedric speak of the art in those disparaging terms. Sir Walter Scott could not fail to be affected, as all poetic natures must be, by the beauty of stained glass.

Mr. W. AUMONIER objected to it going forth that no emotion was to be got out of stained glass. There was a lovely stained glass window in Lichfield Cathedral, which one could not look at without being very much charmed. There was also a very beautiful piece of modern glass in Salisbury Cathedral which had just been completed, the principal characteristics being a field in silver green, with beautiful reds. Personally he did not know anything about stained glass, but he must raise his voice in praise of its beauty.

Mr. CLEMENT HEATON said he should question whether it was a fact that in the days when physical power was predominant art was little appreciated. It seemed to him the contrary was the case: that warriors of feudal times deeply appreciated decorative art—the only art then existing; and that this appreciation was general amongst warlike people, existing among the Saxon and Irish tribes and the Norsemen, to say nothing of the early Greeks and Asiatic races. As regards the position of the craftsman, it would seem as if he held a more important position than nowadays, seeing the way crafts were patronized or worked at by such men as Abbot Suger and St. Eloi. Existing samples are sufficient to show how greatly goldsmiths' art was esteemed, it being used for costly presents from prince to prince, or for donations to religious houses. Stained glass appeared to him to be the offshoot of the great enthusiasm in this branch of art, naturally arising from the enamel which was generally associated with it.

Mr. WYATT PAPWORTH observed that the great Cistercian Order did not allow stained glass to be used in their churches. They would only allow white glass, though all the other Orders had stained glass.

The CHAIRMAN said he demurred to the description of the old white glass as "dirty glass," for that was just what it was not: it was tinted glass. No doubt dirt had accumulated upon the glass, but the glass itself was perfectly pure.

Mr. WYATT PAPWORTH said it was not the pure white glass which was now used; and Mr. Winston, in his work, was particularly strong upon that point.

The CHAIRMAN said he had listened to the paper with a very great deal of satisfaction, both on account of what there was in it, and of the way in which it had been told. Mr. Jackson had alluded to one of the vivid pictures in it; and another was that of the Mediæval artist, who was suddenly seized with the idea of substituting for ornament the figure of a saint. The whole description of this was so graphic and life-like as to be absolutely convincing, whilst you listened. As a matter of fact, probably the artist did not go that way to work; more especially as he obtained his ideas from mosaic, in which figure work always existed. In the early stained glass there was nearly always figure work. No matter how that happened, it did not affect Mr. Kennedy's argument. Once a man got, as he said, at something like nature, his brain took fire, and he was seized with a desire to make it more and more like nature. That was true, and always had been; and to that they owed at once the most masterly form of painting and the so-called realism which modern painters adopted, forgetting everything connected with art in their work. In decorative art, a man's craving for natural effect was only to be satisfied at the cost, to some extent, of his craft. In glass-painting it had led the painter further away from the mosaic method, and induced him to resort more and more to *painting* on glass. That was a direction of work in which Mr. Kennedy confessed that stained glass had yet to triumph. The case of glass-painting had been put very fairly, and no more had been claimed for it than it deserved. For his own part, however, he saw another possible direction in which glass deserved to be developed, namely, the *mosaic*, whence it started. Something might be done with absolute mosaic work, perhaps without painting at all; at all events with very little reliance upon painting, especially in the form of shading. This might limit the use of figure work. For if they were to introduce figures into glass the figure drawing must be up to date, no one would be satisfied nowadays with bogies which did duty for saints in the 13th century. Even then the glory of glass was in its colour. If the introduction of the human form did not lead to beautiful colour—then let it go. It was not necessary. As had been said it was a guest; and if a guest did not know how to behave, he, for one should not invite him, however distinguished he might be. He was inclined to disagree with Mr. Kennedy on one point—when he alluded without disapproval to the method of painting the flesh in glass with a pink enamel. That was rank heresy, a wicked concession to the pictorial; and it was absolutely unnecessary. It was worse than wicked, it was foolish. It was not even resorted to in Renaissance glass at its best, and he had never yet come upon an example of pink enamel flesh which gave him entire satisfaction.

The white glass which the later painters on glass had used, painted in brown, seemed to him absolutely satisfactory. It was always in tone with the rest of the work. The enamel was apt to look rather trivial—pretty enough for a boudoir window, but not otherwise worthy of consideration. It was, what Mr. Kennedy condemned, "producing tone by means of paint, instead of getting it out of material." The introductory definition struck him as very good, "painting in or with glass, instead of on it"; but it would be better to say *working* in or with glass, and drop the word "painting" altogether. Whatever word was used, that was the only workman-like way of treating glass, namely, to work in it, and not on it. The glass painter, in proportion as he could paint, had always been tempted to rely on painting. That was weakness. If by painting on glass an artist attempted to get what could better be expressed by working in glass, he was going astray from the paths of virtue altogether. Glass painters had erred in this respect considerably in the 16th century. In conclusion, he proposed a hearty vote of thanks to Mr. Kennedy.

Mr. KENNEDY said he had been exceedingly pleased to hear Mr. Aumonier's description of the emotional effects which stained-glass work produced upon him, and, in spite of what Mr. Papworth had said, he should be inclined to support the King's College windows as being distinctly productive of emotional feeling in any one who was capable of responding to it. He thought Mr. Papworth's memory seemed to have become a little dim as to the windows when he described them as containing a "few figures." The windows contained the history of the Old Testament as well as the New—from the Creation of life to the Last Judgment, so that the term "few figures" was a little inaccurate. With regard to the use of Chinese-red for producing a flesh tone on glass, he admired the sternness of the principles of the gentleman who spoke upon the subject, but his own preference went the other way. On a sheet of greenish-white glass, that particular enamel produced a soft, brown semi-transparent tint which was not unlike the glaze used by the Venetian painters to represent flesh. Chinese-red artfully put on the green glass was not pink, but a tawny brown, and, being partly opaque, suggested the texture of flesh in a way that no entirely transparent glass did. For the face, one might, for the moment, drop the absolute consideration of the glass, as there the figure-painter came a little to the fore. As to the observation of Mr. Heaton's, about the appreciation of art by the warrior period, he might say that he was not comparing the position of the craftsman in the 13th century with the position of the craftsman of to-day, but was comparing it with the position of the artist in the Greek and the Renaissance periods. Mr. Jackson had spoken against supporting the claim for the man who designed the painting to execute the work, but all he could say was, although it might be described as

impracticable, that he had done it himself. As a matter of financing, there was distinctly *some* advantage in the process. If one had to work out his own designs, he had not to make such elaborate cartoons; they were more sketchy, and he did on the glass freely what would have to be drawn with extraordinary care, if somebody else had to copy it. In the present day, some people did not care very much about stained glass, and they did not seem to understand the difference. Putting aside the question of money, he admitted that one was always bothered with the question of time.

Miscellaneous.

THE DRAWING SOCIETY OF GREAT BRITAIN AND IRELAND.

The following letter has been circulated by the Drawing Society:—

"SIR,—May we be allowed, on behalf of the above society, to appeal for funds to help us in our work? The object of the society, whose honorary director may be addressed at 50, Queen Anne's-gate, S.W., is to promote the teaching of drawing in schools as a subject essential to the general education of every boy and girl. We are supported in our aim by the strong recommendation of the Royal Commissions on Technical and Elementary Education—that simple linear drawing, as a training of the eye and hand, and of the mind generally, should be taught to every pupil in the schools of Great Britain and Ireland, as it has long been in those of the leading countries of the Continent, and also by the recent introduction by the Committee of Council on Education of elementary drawing as a compulsory subject in boys' schools, and as an alternative subject with needlework for boys in infant schools. The society is under the management of a governing body, having as president Her Royal Highness Princess Louise, Marchioness of Lorne, and as vice-presidents, or members of the council, Sir Frederic Leighton, P.R.A., Sir James Linton, P.R.I., Mr. W. Holman Hunt, R.W.S., Mr. E. Burne-Jones, A.R.A., the Right Hon. the Lord Aberdare, the Right Hon. the Earl Brownlow, the Dowager Lady Stanley of Alderley, the Lady Frederick Cavendish, Sir Douglas Galton, K.C.B., Sir H. Trueman Wood, Mr. H. W. Hoare, the Rev. Brooke Lambert, B.C.L., and Mr. T. R. Ablett.

The society provides an annual examination and annual exhibition for the public schools, grammar schools, and high schools. It also grants certificates to teachers, and arranges an annual exhibition for their own painting and drawing.

The funds of the society are under the control of

the council, and the hon. treasurer is the Rev. Brooke Lambert, B.C.L., the Vicarage, Greenwich, S.E.

As the society has not yet been quite three years in existence, its income is not sufficient to meet the unavoidable expenses of organisation which are incident to the beginning of all similar undertakings.

We wish to raise a sum of from one thousand to fifteen hundred pounds, to place the society on a sound financial footing during the few years that will probably intervene before it becomes sufficiently well known to be able to support itself by the fees of its members.

LOUISE P. (Marchioness of Lorne).

CRANBROOK (Lord President of the Privy Council).

J. H. GLADSTONE (Vice-Chairman of the School Board for London).

W. HOLMAN HUNT (Royal Water Colour Society).

T. C. HORSFALL (Hon. Treasurer Art Museum, Manchester).

FREDERIC LEIGHTON (President of the Royal Academy).

JAMES D. LINTON (President of the Royal Institute).

JOHN LUBBOCK (Chairman of the London County Council).

A. J. MUNDELLA (ex-President of the Board of Trade).

J. PERCIVAL (Head Master of Rugby).

E. LYULPH STANLEY (Royal Education Commission).

W. H. STONE (Chairman of the Girls' Public Day School Company, Limited).

BROWNLOW (Under-Secretary for War, President of the Home Arts and Industries Association).

June, 1891.

Obituary.

SIR JOHN HAWKSHAW, F.R.S.—The eminent engineer, Sir John Hawkshaw, whose death took place on Tuesday, the 2nd inst., at his town residence, Belgrave-mansions, was an old member of the Society of Arts, having been elected as long ago as 1853. He took the chair on March 4, 1857, when a paper was read by Major Sears on "Appliances for Facilitating Submarine Engineering;" and again on January 29, 1862; and, in later years, frequently took part in the discussions at the evening meetings. He held the office of vice-president from 1882 to 1884. He was born at Leeds in 1811, and received his education at the Grammar School of that town. At the early age of 20 he undertook the management

of the Bolivar copper mines, in South America—a post which he occupied for three years. On his return to England, Mr. Hawkshaw became engineer to the Manchester and Bolton Canal and Railway, and soon afterwards to the Lancashire and Yorkshire Railway, constructing nearly the whole of their system. Mr. Hawkshaw was nominated one of the Metropolitan Commissioners of Sewers, when that body was formed by the Crown, and in 1860 he was appointed Royal Commissioner to decide between rival schemes for the water supply to the City of Dublin. In 1870 he proposed the scheme for a submarine tunnel between Calais and Dover. It is not necessary here to catalogue Sir John Hawkshaw's great engineering works, but special mention must be made of the line of railway between Charing-cross and Cannon-street, with the two bridges across the Thames; and the Severn Tunnel, which was thirteen years under construction, the first train passing under the river in 1885. Among the most considerable of his works abroad, are the Riga and Dünaburg, and the Dünaburg and Witepsk Railways in Russia, the Government railways in Mauritius, and the great ship canal from Amsterdam to the North Sea. He was the author of "Reminiscences of South America, from two and a half years' residence in Venezuela" (1838), of several pamphlets on subjects connected with his profession, and of papers read before the Geological Society. He was elected a Fellow of the Royal Society in 1855, and held the office of President of the Institution of Civil Engineers in 1862-63; he received the honour of knighthood in 1873; and was President of the British Association at the Bristol meeting in 1875.

General Notes.

ASBESTOS IN NEW SOUTH WALES.—The Government Geologist of New South Wales (Mr. C. S. Wilkinson), according to the *Sydney Morning Herald*, has received several samples of asbestos, which were discovered at Red-hill, near Broken-hill. The asbestos was obtained in a vein measuring from $2\frac{1}{2}$ feet to 3 feet in width, at a depth of 10 feet from the surface. Some of it contains fibre 13 inches long, the texture being silky and flexible. The Broken-hill material is not, however, as strong or tough as the Italian asbestos. The colour, too, is different, as the Broken-hill asbestos is reddish in hue, owing to the influence of iron oxide. It is expected that a white mineral will be found at a greater depth. Several tons of asbestos have been brought to surface.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 8...British Architects, 9, Conduit-street, W., 8 p.m.

TUESDAY, JUNE 2...Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Archer, "The Kemble Period of Stage History."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. 1. Discussion on Mons. Vidal's Paper. 2. Mr. L. Warnecke, "A New Sensitometer." 3. Capt. Abney, "Dark Room Illumination."

Anthropological, 3, Hanover-square, W. 8½ p.m. Rev. J. Sibree, (1) "Curious Words and Customs connected with Royalty and Chieftainship among the Hova and other Malagasy Tribes;" (2) "Decorative Carving on Wood, especially on the Burial Memorials of the Bétsiléô Malagasy; with Illustrative Rubbings."

Colonial Institute, Whitehall Rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Rev. Frank H. Surridge, "Matabeleland and Mashonaland."

WEDNESDAY, JUNE 10...Geological, Burlington-house, W., 8 p.m.

Royal Literary Fund, 8 Adelphi-terrace, W.C., 8 p.m.

THURSDAY, JUNE 11...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. C. Mackenzie, "The Orchestra considered in connection with the Development of the Overture."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JUNE 12...United Service Institution, Whitehall-yard, S.W., 3 p.m. Commander T. A. Hull, (1) "The Handicraft of Navigation;" (2) "Nautical Surveying."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Professor Harold Dixon, "The Rate of Explosion in Gases."

Astronomical, Burlington-house, W., 8 p.m.

Guild and School of Handicraft, Essex-house, Mile End-road, E., 8 p.m. Mr. G. F. Newberry, "Impressionism and Design."

New Shakspeare, University College, W.C., 8 p.m. Mr. W. Poel, "The Stage Directions of the Quartos."

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. W. E. Ayrton and Dr. W. E. Sumner, "Alternate Current and Potential Difference Analogies in the Methods of Measuring Power." 2. Prof. O. Lodge, "A Clock for pointing out the direction of the Earth's Orbital Motion in the Ether." 3. Prof. O. Lodge, "Some Experiments with Leyden Jars." 4. Prof. W. E. Ayrton and Mr. Mather, "The Construction of Non-Inductive Resistances."

SATURDAY, JUNE 13...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. H. Church, "The Scientific Study of Decorative Colour."

Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.

Journal of the Society of Arts.

No. 2,012. VOL. XXXIX.

FRIDAY, JUNE 12, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-Seventh Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 24th June, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD,
Secretary.

CONVERSAZIONE.

The Society's Conversazione will take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday, June 17th.

The reception by the Attorney-General (Sir Richard Webster, M.P.), Chairman, and the Members of the Council of the Society, will be held from 9 to 10 p.m.

Promenade Concerts will be given by the Band of the Grenadier Guards in the North Court, and by the Band of the Scots Guards (weather permitting) in the Quadrangle of the Museum.

A Concert of Old English Music will be given in the Lecture Theatre under the direction of Mr. Arnold Dolmetsch. The instruments used will be those for which the music was originally written—viz, viols, lute, and

harpichord. The first part of the concert will commence at 9.30.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied at the usual refreshment buffets in the Central Corridor of the Museum.

As the accommodation for coats, &c., is very limited, members will greatly promote the general convenience by not bringing with them more wraps than are absolutely necessary.

Each member is entitled to a card for himself, which will not be transferable, and a card for a lady. The conditions under which the use of the Museum has been granted by the Science and Art Department do not permit the sale of tickets; Members will, therefore, not be able to purchase additional tickets for their friends, as in recent years.

The tickets have now been issued to Members.

FOTHERGILL PRIZE.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire.

A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres or other places of public amusement.

In cases where the invention is in actual use, reference should be made to places where it could be inspected.

A full description of the Invention, accompanied by such drawings or models as are necessary for its elucidation, must be sent in on or before the 31st December, 1891, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding the Prize, in case there is nothing in their opinion deserving the award, or sufficiently complying with the conditions, sent in for competition.

Proceedings of the Society.

INDIAN SECTION.

Thursday, May 14th, 1891; The LADY EGERTON OF TATTON in the chair.

The paper read was—

HISTORY AND DESCRIPTION OF THE GROWING USES OF TUSSUR SILK.

By THOMAS WARDLE, F.C.S., F.G.S.

The principal objects of this paper are to place upon record the progress of the utilisation of tussur silk, and to give some account of its history.

Further details concerning its early history, and very limited uses prior to 1870, will be found in my "South Kensington Museum Handbook of the Wild Silks of India," written at the close of the Paris Exhibition, at the request of Sir Philip Cunliffe-Owen, and in the paper which I had the honour

to read before this Society in 1879; but it will be necessary for me to treat at some length on a few points connected with its development, its properties, and structure; and of the countries and peoples from whom it is obtained, as they are subjects too closely interwoven with its present uses to be altogether omitted.

In the "Handbook of the Wild Silks of India," to which I have just referred, I quoted at length a paper from the Annual Report of the Government Central Museum at Bombay, written so early as 1860, by Sir George (then Dr.) Birdwood, who was the first to call English attention to this silk, which he, at that early date, thought fitted to more refined

FIG. 1.



ANTHERÆA MYLITTA, OR TUSSUR MOTH, MALE.

manufacturing uses than it had received in India; and calling the attention of the Government to the importance of cultivating it on a more extended and enlightened scale in that country. The subjects discussed in this most interesting paper relate to the natural history of the silkworm, its food-trees, mode of collection in various parts of India, the reeling of the cocoons, the rude dyeing of the silk, its manufacture into cloth, and full references to the literature of the subject up to that time are also given.

INDIA AND CHINA TUSSUR SILK.

It would have been much more agreeable to me to have confined my paper to a description

of the tussur silk of India, but, inasmuch as there are two kinds of tussur silk known to commerce—one Indian and the other Chinese—my treatment of the subject could not have been either so fair or complete had I adopted this course. I propose, therefore, to speak of both kinds.

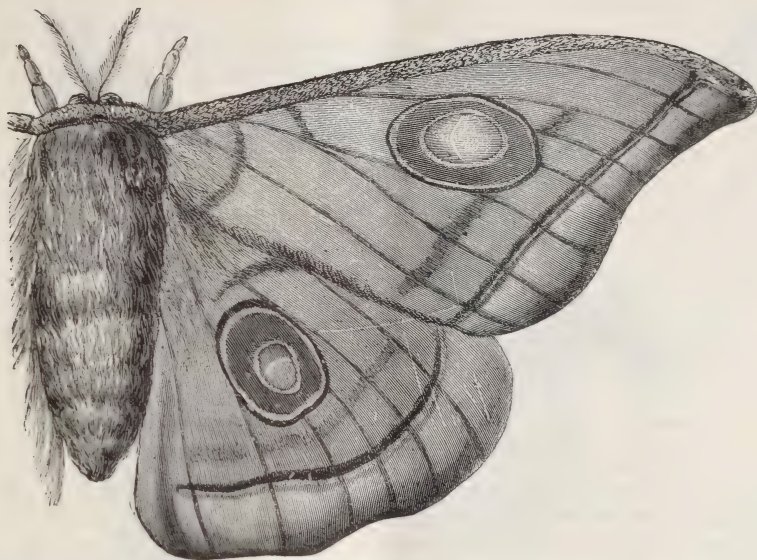
The Indian moth is distinguished, as you see, by four large, transparent, window-like wing spots, larger in the female than in the male, almost of the transparency of glass, surrounded by a purple circle.

The transparent wing spots on the tussur moth are regarded with superstitious reverence by the natives of India, who see in them a resemblance to the *chakra* or *discus* of the god

Vishnu, and from this they consider the moth sacred. In other parts of India these spots are considered to have been originally caused by the finger-touches of Vishnu, and the moth is there also regarded as a sacred insect.

China tussur silk is the product of the larva or caterpillar of the moth known to entomologists by the name of *Antheræa pernyi*, and comes from that part of north China of which Chefoo is the south-easterly limit.

FIG. 2.



ANTHERÆA MYLITTA, OR TUSSUR MOTH, FEMALE.

The Chinese moth has also four transparent wing spots, but they are much smaller than those in the Indian moth, and not so transparent. These naked spots on their wings are

FIG. 3.



ANTHERÆA PERNYI, MALE.

a consequence of the entire absence of the wing scales, which entirely cover the whole of the other parts of their wings.

The Chinese tussur moth differs much in appearance and also very much in colour

from the Indian moth. The microscopical structure of the ultimate fibres also differs considerably. I present to your notice the larvæ, moths, cocoons, raw silk reeled from the cocoons, and also drawings of them, as well as drawings of their respective fibres as seriposited by the silkworm when seen under microscopic enlargement. I also add figures of the larva, imago, or moth, and, further on, the cocoon of the *Bombyx mori*, or ordinary silk of commerce.

The Chinese tussur worm is more insignificant in appearance than the Indian, which is arrayed in a glorious mantle of green. It is also a much plainer one than the Indian, and somewhat smaller.

This caterpillar feeds on the leaves of the oak, and it is different in appearance, habits, and colour from the other tussur silkworm, of which I purposely intend to speak at greater length, and for this important reason, that, as it abounds and flourishes in our great dependency of India, it is on that account more interesting to us than the Chinese tussur, and, for the sake of the people of that great country, it is my main purpose to-day to demonstrate that we should do our best to see its production stimulated there, and also greatly increased.

The dust-like particles, which are removed by the finger when the wing of a butterfly or moth is touched, are revealed by the microscope to be perfectly-formed scales, more or less of a triangular shape; plates pointed at

the end of their attachment to the wing membrane, and widening out at the broad extremities of their lengths into serrated edges, as in the case of *Antheræa mylitta*, or long digitate processes, as in the *Bombyx mori*,

FIG. 4.



LARVA OF BOMBYX MORI OF ITALY.

figured below. The scales vary considerably in size and shape; so characteristic are they in these respects, that it is almost possible to detect the species of the moth by a microscopic examination of them.

FIG. 5.



BOMBYX MORI OF ITALY, FEMALE.

The drawings, as in Figs. 6 and 7, of two species will illustrate this. The wing-scales, as they rest *in situ* on the moth's wing, overlap each other with the greatest precision and regularity, resembling an ornamentally tiled or slated roof.

TUSSUR COCOONS.

There is much difference between Indian tussur cocoons and those of the Chinese worm.

The Indian cocoons are hard, well-formed, shell-like, and shaped like a pullet's egg, and very compact. They vary much in size, the average being about $1\frac{3}{4}$ inches long, and $1\frac{1}{16}$ inches in diameter. the weight is about 16 grains. They possess pedicular attach-

FIG. 6.

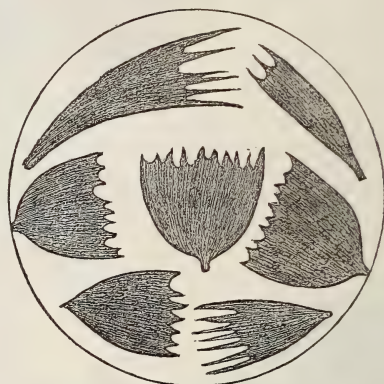
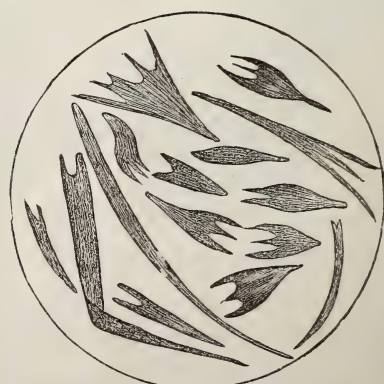
WING SCALES OF THE TUSSUR MOTH.
ANTHERÆA MYLITTA.

FIG. 7.

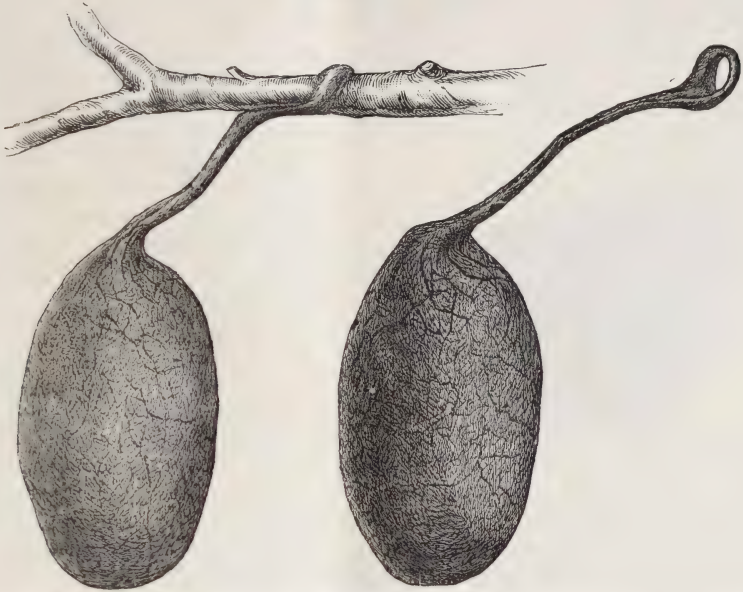
WING SCALES OF THE MULBERRY MOTH.
BOMBYX MORI.

ments, the nature and use of which I shall describe further on.

The forming of the Indian cocoon, and of its attached pedicle, is as follows:—

After the caterpillar has seriposited a few layers of silk thick enough to conceal itself, it extrudes a grumous kind of cementing matter, and by muscular action it causes this excretion

FIG. 8.

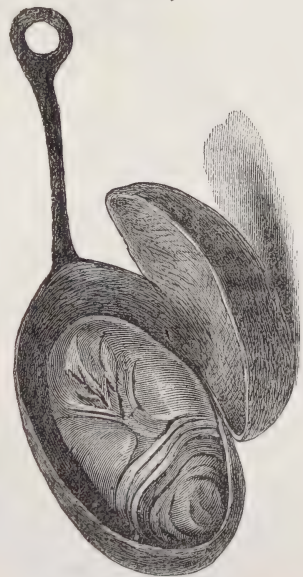


TUSSUR COCOONS WITH THEIR PEDICLES, SHOWING NATURAL ATTACHMENT TO BRANCHES.

intermittently to permeate the fibres, and gradually to solidify the cocoon wall. It thus goes on seripositing layer after layer of small loops of silk, and cementing them together, until the whole of its supply is exhausted; the wall of the cocoon has then become so hard that it requires a sharp penknife to cut through it. The ring at the end of the pedicle, by which its attachment to the branch or twig is secured, and the pedicle itself, are most necessary provisions of nature, for should the caterpillar have begun to make its cocoon in attachment to a leaf only, as those species do which remain for a short time in the chrysalis state, it would fall with the leaf, and doubtless be destroyed by insects or animals; but the tussur chrysalis requires months for its serene and mysterious sleep, and by a marvellous instinct the caterpillar first entwines its silken thread hundreds of times round a branch or twig, and then lengthens this arrangement by seripositing the silken fluid so as to make a thick, tendon-like cord, at the end of which it forms its cocoon, the whole being a marvel of construction and beauty of form, as you see in the drawing, and in these attached cocoons which hang securely from the branches in a fruit-like manner.

After its time of probation in the pupa or chrysalis state, a moist spot is observed at one end of the cocoon. It is now about to emerge from its silken berth; it secretes an acid fluid

FIG. 9.



SHOWS COCOON CUT OPEN, WITH CHRYALIS INSIDE.

which softens the cement of the cocoon, to enable it to separate the fibres sufficiently to allow of its creeping out, being assisted in this by its short pointed wing-spines.

The Chinese cocoon is soft, and has not much definite shape or consistency, being generally formed between two or three leaves of the oak trees on which the worm feeds. The Chinese tussur cocoon measures $1\frac{1}{2}$ inches in length, diameter $\frac{3}{4}$ of an inch, and weighs from 8 to 9 grains.

FIG. 1C.

CHINESE TUSSUR COCOON, *ANTHERÆA PERNYI*.

There are many species of larvæ which produce silk. It is but a few years ago that it was generally thought there were only one or two kinds of silk, but in the Silk Culture-court of the Colonial and Indian Exhibition, upwards of 59 species of silk-producing worms were shown, with the silk they produced; there were also live eggs, cocoons with living chrysalides, and moths of *Antheræa mylitta*, *Antheræa Pernyi*, *Attacus ricini*, *Cricula trifonestrata*, *Samia cecropia*, and a wingless species of an unnamed *Psychidæ* of Senegal. Also another specimen of *Psychidæ* from Ranchi, Chutia Nagpur, Bengal, the caterpillars of which feed on the tea plant.

The great beauty and variety of the living moths excited much attention, but it was left for the afterwork which took place between this Exhibition and that of the Manchester Jubilee Exhibition, to place upon record that a very large number of genera of the moth tribe make silken cocoons of more or less completeness, and in the Silk Section of that Exhibition I was able to show no fewer than 265 species of moths whose larvæ make cocoons; a number of which were exhibited alive in large glass cases in their various stages of existence.

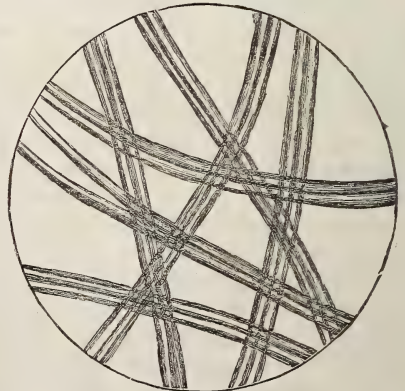
They formed an exceedingly splendid and interesting menagerie of silk-producing *Lepidoptera*, to which many thousands of people were daily attracted. Their names are recorded and several of the species are figured in the illustrated catalogue of that Exhibition.

Now it is of course well known that all the species have the same instinctive object in covering themselves with this silken envelope, namely, to protect them during that wonderful and all but lifeless pupæ or chrysalide state, which, in the mysterious arrangement of their lives, they have for a time to undergo; the caterpillar thus making for itself a veritable and wonderful tomb, from which in due time it rises again in the state of a beautiful and perfect winged insect. It is this silken chamber, which in the case of the *Bombyx mori*, has for so many centuries and decades of centuries been wound off into a continuous thread, and woven into fabrics of such great charm, variety, and utility in India and the further East.

All species of silkworms have two stores of silk, one on each side of the alimentary canal; and below their mouths they have two so-called spinnarets or orifices, to which I have ventured to give the name of "seripositors," through which the silk issues simultaneously in pairs of fine parallel filaments or fibres, forming, in fact, a double thread, which, on exposure to the air, immediately solidifies and becomes silk.

It is of the structure of the fibres of one of these species of silk, and of its growing uses, that I am here to-day to describe, and to report the remarkable progress which has supervened since the Paris Exhibition of 1878, with regard to the great developments in the commercial and manufacturing utilization of tussur silk.

FIG. 11.

FIBRES OF SILK OF COMMERCE, *BOMBYX MORI*.

The differences in the fibre-structure of tussur silk from that of the ordinary silk of commerce, the product of the *Bombyx mori* silkworm is very considerable, and is shown in the drawings.

Thus the fibre of the *Bombyx mori* is round and homogeneous, and resembles a glass rod, as shown in section, Fig. 12; that being the characteristic and structureless form of the silk of all of the *Bombycidae* I have examined.

FIG. 12.



SILK OF *BOMBYX MORI* OF COMMERCE, SHOWING ALSO TRANSVERSE SECTIONS.

But the family *Saturniidae* produce silk of another structure. In all the species of *Saturniidae* known to me, the fibre is always more or less flat, as shown in the drawing, especially in tussur silk. Besides being flat, or tape-like, it possesses structure not unlike the appearance of the warp-threads stretched in a loom before being woven.

FIG. 13.

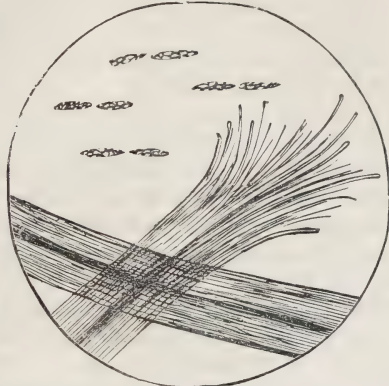


SILK OF *ANTHERÆA MYLITTA*, OR TUSSUR SILK.

The width of the single or ultimate fibre of tussur silk is about the 750th part of an inch, and in this narrow width there are about 20 smaller fibres or fibrillæ lying longitudinally, and connected with each other by a hardened fluid seriposited at the time the worm forms this silken thread. I have succeeded in isolating

these fibrillæ by dissolving the hardened medium, with the result shown in the drawing and in Fig. 14. The fibrillæ of the Chinese tussur fibres are finer and rather more numerous than in the tussur fibres, as seen in Fig. 15.

FIG. 14.



SILK OF *ANTHERÆA MYLITTA*, OR TUSSUR SILK—SHOWING SEPARATED FIBRILLÆ AND TRANSVERSE SECTIONS.

FIG. 15.

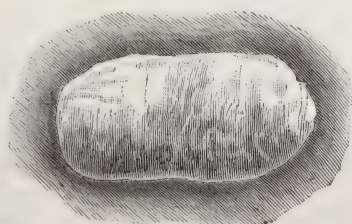


SILK OF *ANTHERÆA PERNYI*, OR CHINESE TUSSUR SILK.

COCOON REELING.

The cocoon of the ordinary silkworm of commerce, the *Bombyx mori*, is soft, and when macerated in hot water the silk is easily drawn off; when reeled and manufactured into skeins

FIG. 16.



COCOON OF *BOMBYX MORI*, ITALIAN.

it is easily dyed, owing to the homogeneous structure of its fibre, which absorbs the tintured matter with regularity, and, moreover, it has a chemical affinity for many kinds of dyes, tans and mordants.

In Tussur silk the opposite of this is the case. It can neither be reeled easily, nor, until recent years, could it be dyed without great difficulty, and by methods which, step by step, have at last succeeded.

With regard to the reeling, I was sent to Italy by the Government of India in 1874, to try and find out a way of reeling Indian Tussur cocoons. Europeans had not at that time been able to soften these hard cocoons sufficiently to allow of a continuous thread being wound or reeled from them.

By the introduction of a friend, Mr. T. H. Gaddum, I obtained permission to visit one of the filatures in Piedmont, at St. Cio, near Torre Pellice. On arriving there I found an extensive mulberry-silk reeling and throwing establishment, situated in a most beautiful valley, in one of the southern spurs of the Alps, about three hours journey north of Turin.

On explaining my mission, and showing the wild cocoons, I was told there was not much prospect of success, for several trials had been made, and they had been found difficult to soften and impracticable to work. I asked to be allowed to try myself. The permission being generously granted, and every assistance kindly afforded me, I was taken to the reeling room, where about 100 young women were at work, with well-trained fingers, reeling the small Piedmont cocoon of *Bombyx mori*. The operation was interesting in the extreme, heightened, as it was, by their strange singing of old French songs, in a dialect not understood by the Italians—a strange and all-but-forgotten tongue—which has to be learned by the mill overlookers, before they can communicate their instructions to them. I was told these girls were the descendants of Huguenot refugees, escaped probably from Provence to the Italian side of the Alps, at the revocation of the Edict of Nantes, and that they still retained their *patois* and their folk-lore; working hard, during the few months of cocoon-reeling, from five in the morning until eight at night, for a franc a day; after work, dancing and singing for the hour before bedtime in the most joyous way. Apartments are provided for them at the factory; and, when the reeling season is over, they separate, and return to their Alpine villages, to wait for the next season's work.

I took some of my wild cocoons, and, with much difficulty and patience, after several trials, succeeded in softening them, by the aid of long-continued boiling in water, to which were added soap, potash, and glycerine. When soft enough, one of the most skilled girls was told off to reel them for me, and, after ridding the cocoons of the outer and coarser threads, she reeled the threads of four cocoons into one, almost without a break, much to her own delight, and to my agreeable surprise.

The next day, the resulting tussur raw silk was taken to the throwing-mill, and there made into organzine and tram, of such fineness as to surprise the managers, who said they had no idea that tussur silk could be made of so fine a thread, and that they should think seriously about sending a person to India, to collect tussur cocoons, that their people might wind them after their mulberry crop had finished.

The usual size—that is, thickness—of thread of thrown tussur silk of commerce was, up to this time, 152 to 255 deniers, that is, skeins of 1,000 yards long, weighing 9 to 15 drams. From some of the finer raw silk, a size of 6 to 7 drams was obtained, but it was generally coarser. From the cocoons the reeling of which I superintended, I obtained a size of 51 deniers, or three drams per 1,000 yards.

Since that time, I have unwound an Indian tussur silk cocoon in an unbroken thread nearly three-quarters of a mile long, and of about three deniers. The reeling of it was effected by the ordinary French and Italian method, known as the system *chambon*. It is figured and described in my "Wild Silks of India;" at that time the system Keller, which is now preferred in many filatures in Italy, had not been introduced.

CHEMICAL NATURE OF SILK.

This paper would be incomplete without a few remarks on the chemical composition of tussur silk, and it will add more to the interest of the subject to compare the chemical natures of both the round fibre of the *Bombyx mori*, with the flat fibre of tussur silk.

An analysis of tussur silk was made under the direction of Dr. Knecht, by E. Bastow and J. R. Appleyard, students of the chemistry and dyeing department of the Bradford Technical College, in 1888, which gave the following per-centage results:—

Carbon	47·18
Hydrogen	6·20
Nitrogen	16·85
Oxygen	29·67
	99·90

They do not state whether the analysis was made of the tussur silk of India, *Antheraea mylitta*, or that of China, the *Antheraea pernyi*; probably it was the latter, and as they differ in structure, and, no doubt, somewhat in composition, a determination of one or the other is still to be desired, and it would be interesting to see the analyses of both side by side, and also of the gum or sericin of each species.

Let me now institute comparisons between ordinary silk and tussur silk. When the raw silk of commerce (*Bombyx mori*) is heated in water under pressure, it yields two compounds, fibroin and sericin, or silk gelatine.

Fibroin constitutes about 66 per cent. of raw-silk; it is a silky, glistening substance, which is insoluble in water, but dissolves in strong acids, alkalies, and a solution of cuprammonium sulphate. When boiled with dilute sulphuric acid, it yields glycocoll, leucine, and tyrosine.

There are two analyses of the fibroin of the silk of commerce (*Bombyx mori*), one by Mulder and the other by Schutzenberger, which are shown in the following table:—

	Mulder.	Schutzenberger.
Carbon	15	71
Hydrogen	23	107
Nitrogen	5	24
Oxygen	6	25

Sericin or silk gelatin has a composition of $C_{15}H_{25}N_5O_8$. It is a substance resembling gelatine.

Its hot aqueous solution is precipitated by alcohol, and after drying, the precipitate forms a colourless powder, which in cold water swells up to a gelatinous mass. On boiling it with dilute sulphuric acid, it yields a small quantity of leucine, and larger quantities of tyrosine and serine, or amidoglyceric acid.

Thus the silk of the *Bombyx mori* consists of two distinct compounds, the pure fibre, which is fibroin insoluble in water or soap, and sericin or silk-gelatin, which is the gum or gelatinous envelope or varnish of the fibre. It is partially soluble in water, and entirely dissolves and separates from the fibre in a boiling soap bath. Tussur silk has also this dual composition.

The following comparative Table shows that tussur silk is composed of the same elements as the silk of commerce, but in other proportions:—

	Tussur silk.	The ordinary silk of commerce, <i>Bombyx mori</i> .	
		Calculated for Mulder's formula $C_{15}H_{25}N_5O_8$	Calculated for Schutzenberger's formula $C_{71}H_{107}N_{24}O_{26}$
	per cent.	per cent.	per cent.
Carbon ...	47·18	47·78	50·26
Hydrogen ...	6·30	6·23	6·31
Nitrogen ...	16·85	18·90	19·84
Oxygen ...	29·67	26·04	23·60

The difference, therefore, between the composition of ordinary silk and tussur silk is as follows:—Tussur silk contains less carbon, according to Schutzenberger's per-centage, which is 50·26; Mulder's per-centage giving 47·78. Hydrogen is about the same in both silks; 2 to 3 per cent. less nitrogen, and about 4 to 6 per cent. more oxygen. I do not consider this difference of composition sufficient to account for the difference in the dye-absorbing qualities of the two silks, which I think depends much more upon their different physical structure, and the chemical nature of the brown colouring matter of tussur silk, not yet ascertained.

Besides this, there is the difference in the amount and nature of the gummy and gelatinous envelope secreted by the respective caterpillars around the fibre at the time of seriposition. In the *Bombyx mori* silk, the gum, or—as the French call it—*grès*, which encases the fibre as a varnish to preserve and protect it, amounts to 25 per cent. and upwards, in the case of China silk, and varies in other silks from 22 per cent. to 30 per cent.; Bengal silk containing the largest amount. The foregoing analyses of its tussur-fibroin shows its nature. The composition of its gum or sericin has not yet been ascertained. From long experience of it I am convinced that it differs in constitution from that of the *Bombyx mori*, and there is a difference also in the sericin of the two tussur silks.

It is much more soluble in hot water than *Bombyx mori* sericin, but it was best removed from the fibre by a boiling soap-bath.

Chinese tussur silk contains more sericin than Indian tussur, and it is generally loaded with saline and dirty extraneous matter. Indian tussur is always cleaner, and contains a higher per-centage of silk.

The following Table shows the reduction of weight of 1 lb. each on China and Indian tussur silks as compared with the same quantities respectively of four kinds of the

ordinary silks of commerce, Italian, China, Japan, and Bengal.

This is from a recent careful examination made by one of my sons for this paper.

Species of Silk.	Weight of 1 lb. after washing in water at 125° F.	Per-centage of loss.	Weight of 1 lb. after boiling in a bath of soap.	Per-centage of loss.
China tussur ...	15 ozs. 11 drs.	13·7	12 ozs. 11 drs.	21
Indian tussur ...	14 ozs. 9½ drs.	9	14 ozs. 5 drs.	11
China.....	15 ozs. 9½ drs.	2½	11 ozs. 6 drs.	27
Japan.....	14 ozs. 11½ drs.	8	11 ozs. 2 drs.	30
Italian	15 ozs. 5¾ drs.	4	11 ozs. 8 drs.	28
Bengal	14 ozs. 14¾ drs.	6¾	11 ozs. 3 drs.	30

The soap, &c., in the manufactured thread must be considered, as the loss is not all natural.

Peroxide of hydrogen reduces a large portion of the brown colouring matter of tussur silk, but causes a further loss of 10 per cent. The gelatinous varnish of tussur silk is undoubtedly much more soluble in water than that of ordinary silk, and a few applications of boiling water will remove it altogether. I hope shortly to examine the chemical nature of the sericin of both the tussur species.

Bastow and Appleyard found a total loss of 26·49 in boiling tussur silk with water, and afterwards with soap solution. This rather points to the silk they examined being a sample of Chinese tussur, and loaded with its usual extraneous matters. I frequently find a still higher percentage of loss in Chinese tussur, occasionally as high as 45 per cent. The specific gravity they state to be 1·440. They found a high percentage of ash in raw tussur, consisting of inorganic substances, in the following proportions:—

	Per cent.
Soda (Na ₂ O)	12·45
Potash (K ₂ O)	31·68
Alumina (Al ₂ O ₃)	1·46
Lime (Ca O)	13·32
Magnesia (Mg O).....	2·56
Phosphoric acid (P ₂ O ₅)	6·90
Carbonic acid (C O ₂)	11·14
Silicia (Si O ₂)	9·79
Hydrochloric acid (C I)	2·89
Sulphuric acid (S O ₃)	8·16
	100·35
Oxygen equivalent to C I	0·65
Total.....	99·70

SPELLING OF TUSSUR.

In India, tussur silk has various names indicative of varieties, such as Tasar, Tasar-Muga, Data, Laria, Bogai, &c., the four latter being applied to varieties of cocoons. In Europe it is known as Tussore, Tussah, Tusser, Tussur. Its general name in India being Tasar, the “a” being pronounced as “u,” it is therefore perhaps more correctly anglicised as tussur, which gives its exact pronunciation. This name is said to be derived from Tasara, a weaver’s shuttle.

DYEING OF TUSSUR SILK.

The difficulties which have presented themselves from time immemorial in dyeing this silk, both in this country, the Continent, and especially in India, would occupy too long a time to relate. Forty-five years ago, my father, then one of the best English dyers, occupied himself in trying to overcome them, but with only very partial success. At that time the subject began to interest me, and I for some years gave special attention to it, but it was before it had occurred to me to study the physical properties and structure of its fibre, and almost before the microscopic powers of good definition and amplitude had been discovered, but I worked on in a tinctorial way with varying success, generally making some progress. Gradually I brought a fuller knowledge of chemistry to bear, which aided me greatly in the better application of tinctorial matter by chemical agencies. At first greys of various kinds were mastered, then a series of brown shades, and after some years of perseverance, reds, blues, greens, but not of very brilliant tones, succeeded, leaving for after years the solution of problems for producing good yellows, pale shades of blues, reds, and tertiary hues. It is singular that black and white were, and yet are, the most difficult colours to dye; I say colours from a dyer’s point of view, because both black and white are colours in that sense, and require the application of tinctorial matter, blue, yellow, and red, but in greatly diversified proportions, to produce them.

My results up to 1870 were exhibited at the International Exhibition at South Kensington, in that year, and appear to have attracted the attention of the India-office.

The reason that the dyeing of black is difficult arises from two causes; the first, the well-nigh impervious nature of the fibrillæ, and their consequent impenetrability to the absorption of ordinary tinctorial and chemical agencies; secondly, the flatness of the fibre,

which causes the light to be reflected at different angles to that of the round fibre of the silk of commerce. This difference of structure causes the natural brilliance of tussur silk to be seen in scintillations instead of being evenly diffused over its surface, and the silk, however well dyed in black, has a speckled, shiny

appearance, as you see it in this hank and in the drawing, but this convoluted or partially spiral narrow tape of shining tin-tape, and this cylindrical rod of the same material, will better illustrate my meaning and more clearly show the difference.

That tussur silk should be more difficult to

FIGS. 17 AND 18.



dye than mulberry silk may well be inferred, from the difference in degree of solubility of the two silks. A neutral solution of chloride of zinc, gently heated, dissolves mulberry silk instantly, whilst it only dissolves tussur silk slowly. In a cold solution, I found it took three days to dissolve mulberry silk, but, with tussur silk, a fortnight's immersion produced no effect.

The natural lustre or brilliancy of tussur silk is quite as great as that of ordinary silk, if not greater; but, owing to its peculiar structure, the effect of an equal diffusion of reflection is not possible.

These peculiar scintillations are not so easily seen in coloured tussur silk as in black. In pale colours, it is hardly distinguishable: the darker the shade, the more observable are its peculiar scintillations, because, at the points of reflection—that is, where they are at an angle of incidence with the eye, from the source of the light—a white point or surface appears, which, in contrast with blackness or a depth of colour, becomes a more noticeable feature. Manufacturers have yet to learn that the peculiar effect caused by this structural difference is really part and parcel of the natural property of the silk, and it ought to be considered, and even welcomed, as such. There is this charm in it, that monotony of structural regularity is broken up and varied.

As soon as I had overcome the difficulties of dyeing this silk in the ordinary colours of that period—for it was before the general adoption or introduction of aniline dyes—I had the honour to receive a communication from the India-office, in which it was stated that the Marquis of Salisbury—then Secretary of State for India—would be glad to know if I would consent to teach the natives of India how to dye this silk, which was both largely used there, as well as largely exported, in a native-

woven cloth, called tussore or tussah, in pieces of 10 yards long.

These cloths were worn by the native women in India in the undyed state, and by English and French women, chiefly for sea-side dresses, also in an undyed state. I have such an example here. I saw many of them being woven in cottage looms in and around Berhampur, in Bengal.

Difficult as it was then to dye tussur silk in the skein, it was tenfold more difficult to dye it in the piece. Here is the best specimen I could find in India of native piece-dyeing.

I replied to Lord Salisbury's request by placing my services at his Lordship's disposal, stating that, as India was so rich in vegetable tinctorial products, I should advise the natives being taught to use them in preference to European dyes, especially as the very feeble and garish aniline dyes were rapidly displacing the old-fashioned and more stable ones. Instructions were at once issued to India for all the known dyestuffs to be collected, and in course of time such a collection was sent to me to examine and report upon, as to more than tax the space at my disposal to store them. It was a most valuable collection, and it took me, with an assistant, more than seven years to examine them. The result of that examination is before you in this Blue-book of eighty-two pages, entitled, "The Dyes and Tans of India," and in these 30 sheets of samples of woven silk, wool, cotton, and tussur silk. The whole collection consists of 360 sheets, containing about 3,500 dyed samples, illustrating the tinctorial results of 181 kinds of Indian dye-stuffs, which show the tinctorial properties of all the dyes commonly used in India. Since that time, a number of others have been reported, and it would be well if they were sent over for examination, so as to make the whole book complete.

In parenthesis, I feel bound to mention that a work of this laborious and valuable nature has, as far as my experience goes, never had such scant treatment at the hands of the Government of any country. My book, as far as any usefulness it possesses either to India or to Europe, is a dead letter, and it had been more economical never to have published it. It, so far, has been love's labour lost.

The method of publishing it was of the most parsimonious kind, entirely counteracting its usefulness. In vain I urged that it ought to be published in England, and to have the methods by which I succeeded in obtaining the beautiful colours you see here inserted in the book, and, what is quite as necessary, to have pasted in the book small patterns of these coloured results, either the dried samples themselves or by chromo-lithography, obtained as they were by a more scientific application of mordants than those known to, or practised by, natives of India. When I went to India at the request of the Government in 1885, and showed my results, with their own dyes, to the native dyers, they were immensely surprised, and doubts were expressed as to the possibility of obtaining such excellent results with their plant dyes, but when I told them of the impure states of their *sagi-matti*, alum and proto-sulphate of iron, almost their only mordants, as compared with the purer European salts, and also with a much larger range of metallic salts, which could be used with much better effect as occasion and colour required, they were convinced that, good as their dyeing, and especially printing, was, it was capable of great improvements. At Saharanpur, as Dr. Duthie, the curator of the Botanic Gardens there, will remember, if he should be present to hear me, I went the round of the dyers' and printers' with him, and each set of men, three or four in each dye-shop, in succession followed the rest, and, after I had seen everything I desired they sat down, at least, 50 or 60 of them, in a circle, with Dr. Duthie and myself in the centre, to examine the specimens I had brought with me. The spokesman, an old grey-haired Hindoo with dyed turban and white waistbelt, rose and said in Hindoo, "We have told Sahib all he asked us about our methods, will he answer any questions we would like to ask him?" I replied I should be delighted to do so, and for half an hour I was subjected to a cross fire of interrogations, such as only experts in the tinctorial art could ask, and which I freely answered. After

passing my patterns round for some time, the old Hindoo rose and asked Dr. Duthie to state, that if Sahib would come to Saharanpur and establish a dye and print works on the English system, that both masters and men would willingly come and work for him. That was certainly a very encouraging, flattering, and striking episode in my interesting study of Indian dyeing and printing in India. Since that time, for all art work, I have chiefly used Indian dyes, from which I succeed in obtaining results in tone and permanence absolutely impossible with any artificial dyes, good as some of them are, and if the Government had followed up my arduous work for them in a prompt and thorough way, I am sure Europe would now have been doing a large business in dyes with India for all their *bon teint* purposes, and the Indian dyers themselves would have been able to make themselves acquainted with superior methods at present unknown to them. The way in which indigo, for example, still asserts itself is a sufficient proof.

But it is not too late. As taste improves, the weaker dyes are more disliked, and I would from this place urge the Government of India to make the work, so successfully begun by Lord Salisbury, complete. The Hindoo and Mahomedan dyers still remain untaught in the application of chemical science to their art, and the European dyers remain unaware of the excellencies of scores of, to them, unknown Indian dyes.

BENGAL SERICULTURE.

I will now turn to other interesting episodes of my Indian investigations. On arriving at Bombay, I received a message from Sir E. C. Buck, Secretary of Revenue and Agriculture, to proceed at once to Calcutta, where I received his instructions to visit the Bengal sericultural districts, where the Bengal silk of commerce is produced, the silk of the *Bombyx fortunatus* and *Bombyx cræsi*, and to report upon the causes of their depressed condition and diminished output. I first went to the districts of Rajshaye, in which Surdah is situated, and then on to Berhampur.

I took with me this Italian tavelette (Fig. 19), which I found in Italy to be producing the best reeled silk, and explained its use practically in several filatures. Fig. 19 (p. 619) is a drawing of it.

I returned to Calcutta, and read a report, since published by the Department of Revenue and Agriculture, before an important meeting

of gentlemen interested in the subject, and presided over by Sir E. C. Buck.

I found in some filatures very defective reeling, in all possibilities of improvement, but in the native-reeling villages the reeling

FIG. 19.

A.—An iron stand 12 inches high.

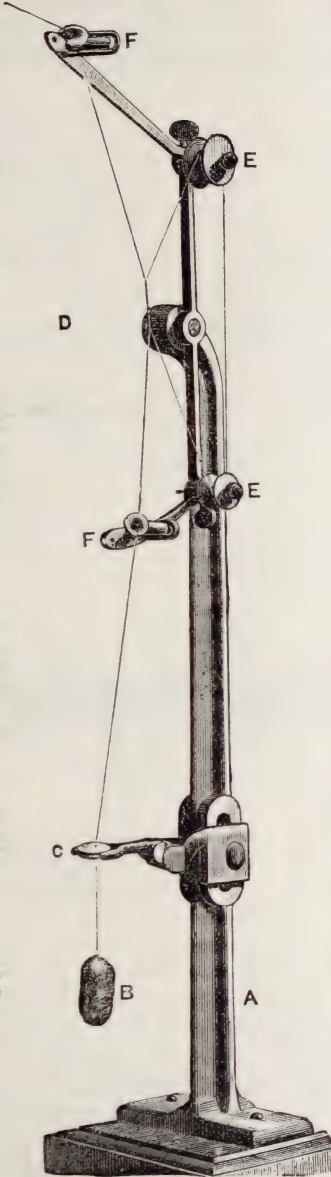
B.—Cocoon and its thread placed so as to show the position of the silk on the instrument.

C.—Filière, a porcelain disc, pierced in the centre, and concave on the lower side. The threads of four or more cocoons pass through it and form a compound thread of "raw-silk."

D.—Croisure or crossing of the raw silk thread six or more times round itself. The object of this is to straighten and remove kinks, loops, and irregularities in the thread.

EE.—Pulleys, the drums of which are formed of thin glass rods.

FF.—Porcelain eyelets or guiders attached to a brass frame which also supports the pulleys.



ITALIAN SYSTEM OF REELING COCOONS.

Tavelette Keller; sometimes, but erroneously, attributed to Consono.

was wretchedly bad. In the cocoon-rearing villages I found much preventible disease. Generally about 60 per cent. of the worms died from pebrine and other diseases. Let

me draw a comparison between this rude and imperfect native system of reeling tussur cocoons and the European one. It will be easy to point out the superiority of the Italian method in two ways—first, the operation termed the *croisette* in France, is better done with the *tavelette* than by rubbing with the palm of the hand; the *croisure* effected by the hand is no *croisure* at all—merely a rolling of the individual fibres together. The operation of *croisette* effects the laying together into one compact thread the threads of two or more cocoons (usually from four to six), and in drawing off the pairs of individual cocoon threads or baves in a continuous and stretched-out manner so as to prevent, as far as possible, what the French call *duvet*, or thread irregularities.

The silkworm, by moving its head from one side to the other, deposits its double thread in loops, as at *a*, see Fig. 20 (p. 620).

At the points of contact, the gum adheres more firmly than it does laterally, consequently, in the reeling, the bave—that is, the double parallel fibres—frequently come off in loops, as at *b*, Fig. 20.

In Fig. 21 (p. 620) is given the appearance of *duvet* upon a thread of raw silk composed of four cocoons reeled together.

Fig. 21 (p. 620) is the microscopical appearance of an aggravated form of *duvet*, in which a series of layerlet of loops have come off together, and which, having passed both *filière* and *croisure* without being reduced, have resolved themselves into a tangle which constitutes what is known as "knibbiness" in the raw silk.

In native reeling it is much worse, and much more frequent. In the Bengal cocoon this defect is much aggravated from two causes—first, by the greater amount of gum or *grès* which the worm exudes to cover its silken thread than in those of the Italian, French, Chinese, and Japanese worms; second, from the Bengal cocoon being smaller and softer than those countries just mentioned. smallness increases the difficulty of reeling, especially towards the inner end of the cocoon.

In the Italian cocoons the chrysalis is larger than the Bengal ones, and helps by its greater weight to prevent the cocoon from being drawn out of the water in which it floats whilst being reeled.

Often for want of care whole layers come off at once, and form what are called "knibs," "foul," "slubs." This is particularly noticeable in village native reeling where irregu-

larities of thread predominate, portions of the cocoons being drawn off in positive lumps.

The *croisure* materially helps to pull out the loops by running the threads round the pulleys at a considerable tension, and then by crossing them several times round each other as shown at *a*, Fig. 20. The threads plane against each other and the *duvet* is reduced. *Duvet* occurs in the best reeled Italian and French raw silks, but to such an extremely limited ex-

tent in the higher or better reeled qualities as to be almost invisible.

I did not meet with any one in Italy, when studying this defect, who could explain its true nature or cause, and I pointed out under the microscope that it was simply unresolved loops, which in all good reeling must be pulled out to form a straight even thread. This, the Italians think, is best done by the Tavelette Keller. (See Fig. 19, p. 619.)

FIG. 20.

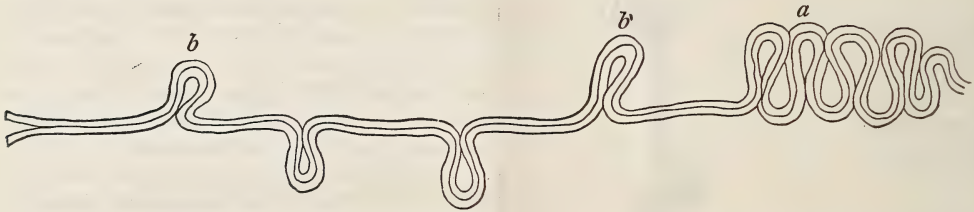


FIG. 21.

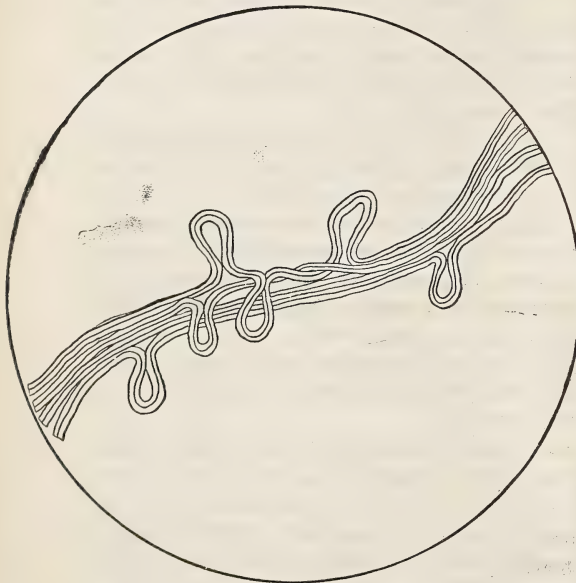
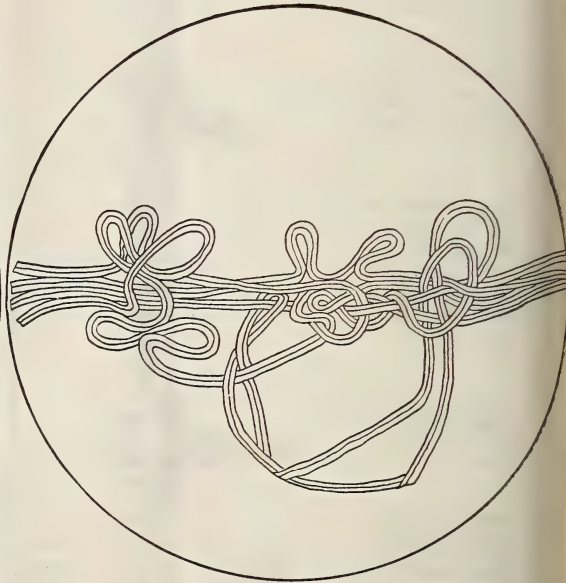


FIG. 22.



Our Indian sisters could thus substitute a more cleanly and less toilsome method for their own, which to us seems burdensome and indelicate, requiring them to sit the live long day upon the clay floor much exposed. Several of the old women reelers at Futwah were much bent and very rheumatic by their many years of toil in a constrained position upon a cold floor.

The Figures 23, 24, and 25 (p. 621), show a microscopic representation of defect and cure of *duvet*. They accompany a pamphlet issued by the Chantier de la Buire Compagnie,

machinists of Lyons, descriptive of a new automatic cocoon-reeling machine, which they allege obviates skilled labour.

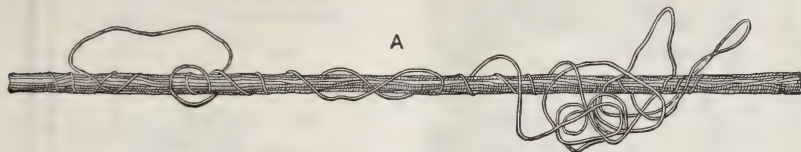
There were also other difficulties fully mentioned in my report, all of which could be easily ameliorated by an Imperial bacteriological and educational effort, similar to that in France and Italy, and which I strenuously urged. A station has since been established at Berhampur, and is directed by Mr. Nityal Gopal Mukharji, who was first sent to the Government Sericicultural establishment of Montpellier and Padua, after having

studied the treatment of the various silkworm diseases at Paris under M. Pasteur.

Much improvement in reeling has been recently effected, and Bengal silk finds more

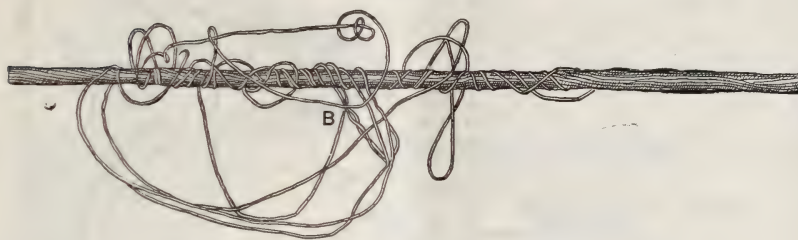
favour in Europe on that account, and it has now a value of upwards of 3s. per lb. over the price obtained for it at the time of my visit.

FIG. 23.



REELED BY A GOOD FRENCH REELER BY HAND, SYSTEM CHAMBON.

FIG. 24.



REELED BY AN APPRENTICE BY HAND, SYSTEM CHAMBON.

(Magnified 50 diameters. A & B, duvet.)

FIG. 25.



REELED MECHANICALLY, NEW SYSTEM. (CAMEL.)

(Magnified 70 diameters.)

MANBHUM TUSSUR-CULTURE.—

THE SANTALS.

I was then despatched by the same authority to Manbhum, in central Bengal, to report on the capability of the Santal people and district to increase their output of tussur silk, which was at that time in vastly increased demand.

I stopped at a jungle station called Jamtara. Here the Rev. A. Campbell, a missionary, met me with twelve of his Santal people. We journeyed five hours into the interior, to his bungalow at Pokhuria, in Govindpur, a sub-division of Manbhum district, not far from which is the celebrated and sacred mountain, Pareshneth, 4,460 feet high.

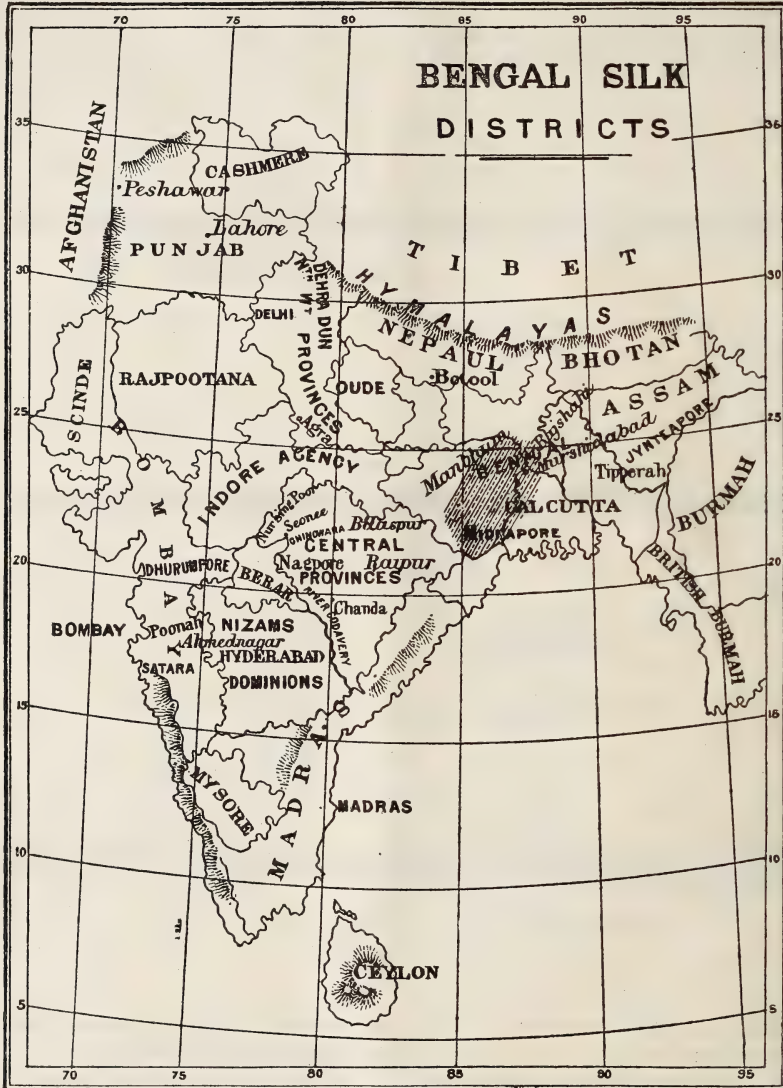
I found myself now far away from all Hindoo and Mahomedan civilisation, amongst a tribe of demon-worshipping Santals, who live in

alternating villages with the Kohls, both peoples being tribal aborigines.

The day after my arrival, I was led into the jungle by Mr. Campbell, who had previously shown me, for the first time, two beautiful full-grown tussur silkworms, feeding on a tree in his garden. The tree was a young *Terminalia tomentosa*, one of a number which he had some time before planted, in order that he might study the cultivation of the tussur-worm for silk-producing purposes, and to instruct the natives.

They are both preserved in spirit, in this bottle; but they have lost somewhat of their size, and also their beautiful colour. But both colour and size are well-illustrated in the enlarged drawing on the screen, and in that showing its natural size. I had never before seen such a beautiful living object, and I felt

FIG. 26.



(THE SHADED PARTS SHOW THE BENGAL SILK DISTRICTS.)

quite repaid for all the attention I had given to tussur silk (Fig. 27, p. 623).

Deep in the jungle, I was brought to the last season's tussur breeding-station, and, in an acre of forest, a most desolating appearance I beheld.

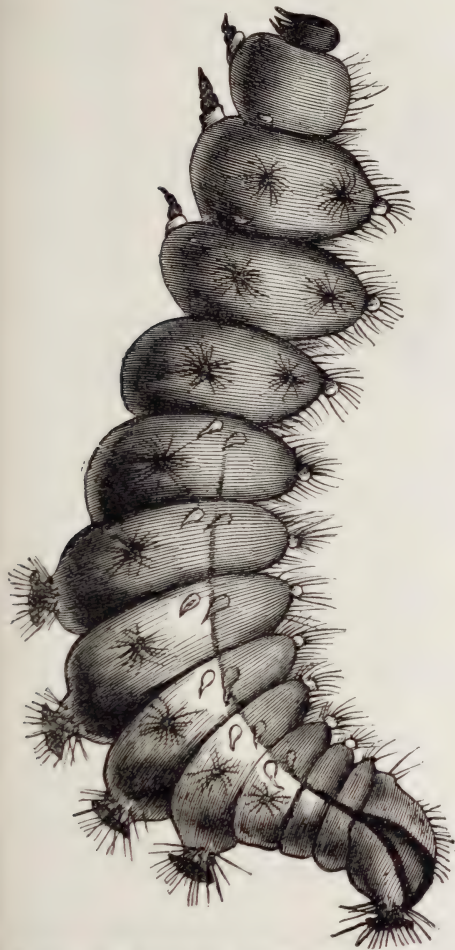
Most of the trees were *Terminalia*, of two species, and *Shorea robusta*. They presented that bare and shaggy appearance which can be imagined when all the leaves are stripped off, and all the smaller branches lopped.

The leaves had been devoured by the tussur caterpillars. After this feeding-stage of their existence, they began their cocoon construc-

tion, by first attaching to the twigs the pedicles on which they formed their cocoons. When the gathering time came, the Santals, instead of cutting the pedicle, and allowing the cocoon to drop, cut off the twig, cocoon and all, with hooked knives and long sticks. This caused the trees to die; and Mr. Campbell said he had failed to dissuade them from this absurd practice, because of their love and determination to claim uninterfered-with forest rights. He asked me to address them on the subject, and the next day they invited me to join their hunt, and to see them armed with bow and arrow, and accompanied with four bamboo

fifes and two tom-tom drums. We came across several dead patches of trees, the wreck of previous years of tussur culture. In one of them I stopped, and made an earnest appeal to them—about 50 in number—not to kill the trees, but to lop off only the cocoons; and on my telling the fable of the goose and the golden egg, solemnly translated into their Santal

FIG. 27.



LARVA OF *ANTHERÆA MYLITTA*, OR TUSSUR SILKWORM.

tongue by Mr. Campbell, they were so impressed that they promised me that my wishes should be complied with in future. But my object in mentioning this is to point out the immense area of jungle forest in which grow the trees whose leaves form the best food for the worms. As far as the eye could reach from any rising ground, and for hundreds of square miles, there lay a forest in which it seemed any quantity of the tussur of the future

might be cultivated, and I think it is worthy of the attention of the Government of India to encourage in every way a greatly increased production, and not to be behind China in this respect, remembering that it has once happened, when I showed how tussur silk could be utilised, that such a demand sprang up as was chiefly met by the greater quickness of the Chinese.

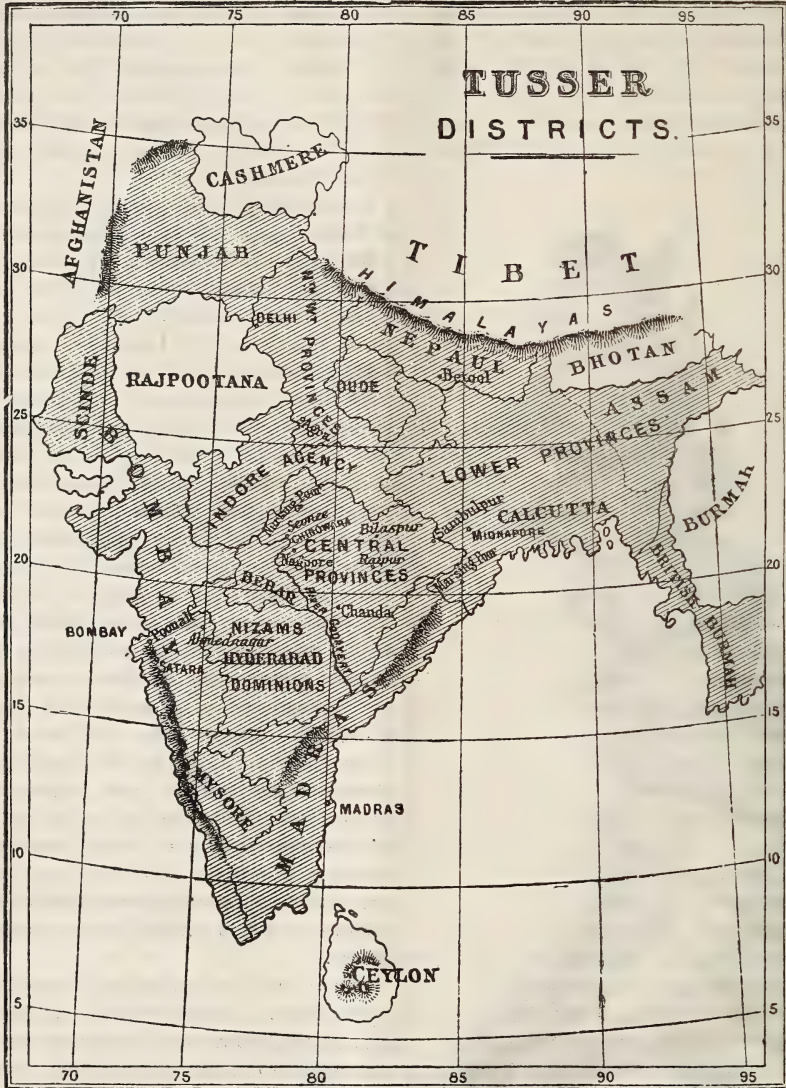
Practically speaking, over the greater part of India, tussur silk might be cultivated, and there is vastly more area for such a purpose than there is there for growing cotton, as may be seen from the shaded parts of the map (Eig. 28, p. 624), where, I have been informed, the tussur moth, in greater or less abundance, is to be found (Rajpootana is not shaded, because I had no reliable information about that part of India). I shall, by and by, add force to these remarks by showing you how enormously the consumption of tussur silk has increased in Europe since 1878, the Paris Exhibition year, and consequently what an increased demand presents itself for India to supply. It has been a disappointment to me to see India, for whom only I was so anxiously working, so lethargic during such yearly increasing requirements, and allowing China to send in the lion's share of supply. As we often find in the English character, so I found in the Anglo-Indians, a greater readiness to find objections than means, and to this must be added the lethargy of the natives, and so India has missed an initial opportunity, which I hope the now greatly increased and secured state of European consumption will prompt her to secure for the future.

This is not the occasion to speak much of the Santals. I could easily fill a volume with an account of my most interesting and charming visit to these people, but I may be pardoned, if only to relieve the monotony of a dry address on silk, to give a brief outline of what I learned about them from Mr. Campbell and from my own observations, and of their beautiful country; and, besides, I have a purpose in doing so which is strictly related to the question of tussur culture.

The Santals are a people whose mountain home originally was in the Himalayas. They now inhabit the western frontier of Bengal, almost from the sea to the hills of Bhagulpore, on an extent of country of about 400 miles long by 100 miles broad, or about 40,000 square miles.

In the more westerly parts of this large tract they are the only population, altogether

FIG. 28.



they are about 1,500,000 in number. They are children of the forest, speaking one language, the Santal language. They have no written language, but my friend the Rev. G. Campbell, gave me little books in which their language has, by various missionaries, been condensed and printed, containing hymns which I had the pleasure of hearing sung, or rather chanted, to their native Gregorian-like strains, by the Pokhuria Santal maidens who assembled in Mr. Campbell's bungalow, that I might hear them.

As a resemblance in language I will just mention one word, "man," which, primarily,

signifies a thinking animal, and has in Sanskrit "man," to understand; "manu," the first man; and "manava," man in general; whilst the Santals have "man-ete," to think; "man-e" the soul; and "maniko," the first man; with "man-o-i," in general; and "man-jaman, born of man.

The Santal is very well proportioned, his height is about 5 feet 7 inches, weight about 8 stone, strong, very hardy, round-headed and round-faced, with a pleasant expression; the women especially clothed but very scantily, not too little, not too much, garments in such a hot country being an encumbrance.

SANTAL CUSTOMS.

They have all the same customs; they are of one race of seven tribes, a division derived from their belief in the seven children who were the progeny of their first and common parent-ancestors. They have all the same religious customs, but it is religion minus a beneficent god. The Santal can only believe in a supreme being whose object is to harm him—a religion of terror, and a praying against evil, and not a praying for good. The effect of the missionary, when explaining the attributes of the Deity, is to make them fear still further, and to exclaim, “and what if he should eat us.” They believe in evil spirits, and in many rites and ceremonies to propitiate them, each family having its own deity, and unknown to other families; the knowledge of the family god is transmitted from generation to generation by the death-bed communication of the father to the eldest son, and it is a representation of the secret spirit and principle of evil which has an unseen but ever present embodiment in each house.

Besides, their family religion includes the worship of the ghosts of their relatives and ancestors, which require pacification in order to prevent them being hurtful to the family, by inflicting sickness or other domestic and agricultural troubles.

I have seen their clay altars, and their sacred groves where they go to rate and blame their ancestors, with violent gestures striking the altar on the loss of a cow or other trouble.

They have in every village a sacred grove, consisting of about a dozen large *Sal* or *Shorea robusta* trees (a favourite food of the tussur worm) and seven stones, some marked red. They believe the grove is the resort of their deified spirits and ancestral ghosts, and there they celebrate their rites and festivities in joyous dancing, or appeasing sacrifices to the demon and evil spirits whose malignance they are for ever fearing, and against which they are ever supplicating, and as has been aptly summarized, they know no god who will reward the good, but a host of demons are ever at hand to punish the wicked, to scatter and to spread murrain among the cattle, to blight the crops, and only to be bribed by animal suffering, and by a frequent outpouring of blood in sacrificial rites.

I asked my missionary friend, if this religion was such a deeply-rooted one, and so opposed to our ideas, how he managed to make Christian converts. He said it was next to impossible to do so; but his influence with them,

as I had daily opportunities of observing, was immense. It was more of a fatherly and friendly kind than that of a change of belief; a possible grafting of the new upon the old, requiring, perhaps, ages for its consummation. In a dozen years of devoted missionary work he had made but few Christians, and those chiefly of his own *entourage*, yet he was all but worshipped, and I never saw such devotion to any one man. He told me he frequently camped out amongst the various tribes in turns, and often preached to upwards of a thousand people, young and old, of both sexes, who flocked from far and near to hear the great father, who was their trusted friend, both against the rapacity of the Hindoo, whom they both feared and hated, and in their troubles and disputes of all kinds, as well as being their great “medicine.”

The Santal youths marry at about sixteen, and the maidens at about fifteen; and, as Dr. Hunter states, a leaf hut, with a few earthen and brazen pots, is all the establishment a Santal young lady expects. The houses in their villages were of clay or bamboo with a sloping roof, in contrast with the houses in the Kohl villages, whose houses had flat roofs.

The Santal maiden sometimes claims her right of choosing her lover. To do so, she takes a dish of prepared rice, and he is done for; he must eat it, and is bound to marry her. The marriage takes place in the market before witnesses, when he dabs her forehead with red paint.

To me the Santals were very kind and considerate. They carried me on their bare shoulders across rivers; showed me how to use their bow and arrow, their only weapon. The young women sang to me; both young and old men showed their powers in aiming their arrows at a fixed mark; in other games; and in hunting in dense jungle, using arrows pointed with sharp spear-heads of native steel for large game, and a wooden button at the arrow end for birds, which they can hit flying. It was a highly-privileged and never-to-be-forgotten experience. One of the oldest men, after giving me a proof of the accuracy of his aim, pressed upon me the acceptance of a lasting memento in the shape of his beloved bamboo bow and arrow, which I have brought as one of the illustrations to my paper. The bowstring is also bamboo (Fig. 29, p. 626).

But most wonderful of all is their account of the origin of the world and mankind, and in their traditional beliefs in these respects. They bear great resemblance to the Mosaic record

in several particulars, analogous to the creation, the deluge, the first human pair, their first being clothed, propagation of children, the dispersion; the formation of the earth by its being raised up above the sea (which was of old universal) at the command of the Great Lord Marang Buru, who called a tortoise to lift up the earth, and when he had done so the Great Lord found it not to be solid enough, and commanded the tortoise to sow the seeds of grass to let the roots first take hold.

Their household god is the Great Mountain,

which represents a life-sustaining providence, to which they offer sacrifices of blood. Their priests worship the brother and sister who were the first man and the first woman of the Great Mountain, and sacrifice to them white goats and fowls on the banks of the Damooda, or with a red flower or red fruit, typifying thus a blood sacrifice.

Sir William Hunter relates a modified version of the tradition, which varies in different parts of the Santal country.*

The Great Mountain stood alone among the

FIG. 29.



SANTAL BOW (UNBENT) AND ARROW.

waters and talked to himself in solemn solitude. He saw that birds moved upon the face of the waters, and he put them on a water-lily in the midst of the waves and let them rest there. The huge prawns were created, and the prawns raised rocks from under the waters, and likewise the water-lily, the rocks afterwards became covered with all manner of creeping things, and the Great Mountain said, "Let the creeping things cover the earth" and they covered it. Then the Great Lord commanded the Great Mountain to sow grass, and when the grass grew up the first man and woman arose from two duck eggs that had been laid upon the water-lily. Then the Great Lord asked the Great Mountain, "What are these?" and the Great Mountain answered, "They are man and woman. Since they are born let them stay."

The Great Lord saw they were naked, and he commanded the Great Mountain to clothe them, and he clothed them. Then the Great Mountain said, "The land is, and the man is, and the woman is, but what if the man and woman should die out of the land. Let them have children, and they had seven."

The tradition of these people, from which their present seven tribes spring, rather mixes up the creation with the deluge, and, probably, begins with the deluge and subsidence of the waters, or, rather, as Sir William Hunter puts it, the Santal legend describes rather the subsidence of waters than a creation.

Their river Damooda, of which the Barak-

har, which I crossed, being carried over its dangerous sifting sands on the bare backs of three Santals, is the main tributary. It is held in veneration by the Santals, who make an annual pilgrimage to its banks, to consult the prophets and diviners, and to commemorate their forefathers, by a ceremony, which they call the purifying for the dead. Sir W. Hunter relates that, however remote the jungle in which a Santal may die, his nearest kinsman carries a little relic of the deceased to the river, and places it in the current, to be conveyed to the far off Eastern land from which his ancestors came.

Sir William Hunter relates that instances have been known of a son following up the traces of a wild beast, which had carried off his parent, and watching, without food or sleep, during several days for an opportunity to kill the animal, and secure one of his father's bones to carry to the river.

Mr. Campbell told me that immorality was almost unknown amongst them, and, when it did occur, expulsion and death in the jungle was the fate of the unhappy outcast. The Santals have one wife only. I could write pages of what I learned as to those interesting

* The "Annals of Rural Bengal," by W. W. Hunter, LL.D., a most interesting work, which not only agrees with my Santal experience, but contains a more exhaustive account of this tribe than I had opportunities of observing, and to which I am here indebted. I had the pleasure of meeting Sir William (then Dr.) Hunter in Calcutta.

phases of life, courtship, marriage, death, and burial (a beautiful ceremony), and the future world; but this is not the place, for, fascinating as the subject is, I have already digressed too much, but only to bring vividly before you the interesting country in which the Santal dwells—his lowland and mountain junks, produce of wild silks, beautiful dyes, gums, tans, drugs, bees'-wax, timber, and, as Sir W. Hunter states, a little world of barbaric wealth, to be had for the taking, and last, but not least, the home of the tussur silkworm, where, by due attention to tussur sericulture, may be produced silk in inconceivable quantity.

SANTAL TUSSUR-CULTURE.

But to return to Santal tussur silk. The price at which the Santals sell their tussur cocoons is 5 to 7 rupees for 800 cocoons.

The Santal tussur silkworms, which produce the selling crop of cocoons, feed on the *Terminalia tomentosa*, and form their cocoons on its branches in October. They are gathered as soon as the cocoon hardens, which is in three or four days after the cocoon is completed.

The worms for the breeding crop are fed on the *Shorea robusta*; they make their cocoons on the same trees towards the end of the hot weather. The term of the chrysalis stage varies a good deal, some of the moths emerge in one, two, or three months, some at four, five, and even six months.

Mr. Campbell told me he had had some of the October brood which did not emerge until the following June. The moths fly high, and are only to be found on tall trees. The male moth always flies at night, from dark until about two the next morning, and is known to travel very long distances.

The female moth flies from tree to tree, depositing three or four eggs on the leaves each time she alights, and, whilst laying her eggs, her wings are always in motion.

For domesticating, the females are put into a basket, so that all the eggs are gathered, but in the wild state she lays her eggs always on leaves. They will keep for ten or twelve years.

In cultivating the tussur worm in a semi-domesticated way, by the Santal, it is fed on gathered leaves. The eggs are taken into the jungle in little bags, and are attached to branches, and they are then watched incessantly night and day for a week. The *Semecarpus anacardium* is used on a stick to catch insect pests. To prevent the ants from

climbing the trees, they either tie a leaf round the tree, or make a mark round the stem with the oil of *Semecarpus*. No insects will pass over it. I saw many trees so ringed at the base.

The important cocoon harvests in Manbhum are in October and November, but there are as many as six broods a year. The principal food-trees are:—*Terminalia chebula*, *Terminalia bellerica*, *Terminalia tomentosa*, *Terminalia arunja*, *Shorea robusta*, *Zizyphus jujuba*, *Lagerstroemia parviflora*, *Careya arborea*, *Diospyros tomentosa*, *Alstonia scholaris*.

Mr. Campbell said the best plan to promote increased tussur culture there would be for some capitalist to take the forests and employ ryots to collect the cocoons, conditionally that they did not lop the trees. He said tussur culture would then be enormously developed.

I stayed nearly a week amongst them, hospitably entertained by the Rev. Mr. Campbell, whom I found greatly revered by them. I found them a most interesting people, affectionate, of strict morality, and most obliging. The same twelve who brought me from the railway station into their wilds, took me to Janture; I on pony-back, and they, all but nude, carrying my luggage hung to each end of poles carried over their shoulders. I had lingered too long on my last day at Pokhuria, and it was late in the day when I left, so we had to traverse the roadless jungle for three hours in the night, with no other light than a lantern and the stars overhead, and occasional colonies of fireflies slowly sailing about, amid the roars and howls of tigers, leopards, panthers, and other feline animals,* the unearthly cries of hyenas, the diabolical yells of packs of jackals, sometimes close to us, other packs distances away, yelling to each other, like villages of demons with wild dogs, and never knowing which moment might not find one of us seized by a tiger; for this part of Bengal is the home of tigers. I rode with loaded rifle in hand, and it was a relief to all of us when we arrived at Jamtura station, about ten o'clock at night, where I waited for the night mail, which took me to Bankipur for Gaya.

* There are nearly twenty species of the genus *Felis* in India, of which *Felis tigris*, the Bengal tiger (Hindee, *Bagh*), *Felis pardus*, the panther (Hindee, *Gorbach*), *Felis leopardus*, the leopard, *Felis jubata*, the cheetah, are the principal ones, and are common; *Hyena striata* (Bengalee, *Naukra bagh*); jackal, *Canis aureus* (Hindee-Bengalee, *Sian*); wild dog, *Canis rutilans*.

GAYA.

I arrived at Gaya the next day, on the 29th of January, 1886, at 10 o'clock, where I met Dr. Macleod, to whom I had a Government letter of introduction.

This centre of places is held in veneration by Hindoos, both in the adjoining semi-mountainous country and in the plains abounding with historic rock-temple remains of the great Buddhist faith, now extinct, but which in almost prehistoric times prevailed there, culminating at Buddha Gaya, about six miles from Gaya. The town of Gaya has a population of 76,000, 60,000 of whom are Hindoos. Part of the town is occupied by the residences of the priests, and there is also the trading quarter.

I found a rather large tussur cocoon collecting centre at Gaya, collectors penetrating the vast jungles south of Gaya and far into the extensive division of Chota Nagpur, of which the towns of Hazaribagh and Ranchee, respectively about 60 and 120 miles distant from Gaya, are well-known centres of tussur cocoon production; the neighbourhood of Ranchee being also where I first obtained the interesting cluster-cocoons of grape-like growth of the *Cricula trifenestrata* worm, which excited so much attention at its first introduction into England in the Silk Culture Court of the Colonial and Indian Exhibition in 1886.

At Gaya I found tussur cloths of this description being woven, and consequently a good deal of cocoon reeling done in the same manner as at Fatwah and Arrah. Here are samples of two qualities of tussur reeled raw silk I brought from there. It is of superior quality, being fairly well reeled, and this is a 10 yard piece of their weaving.

I bought two bundles of native reeled tussur raw silk for eight annas. The price of cocoons was 10 annas per 1,000.

The tussur cloth weavers earn four to six annas per day, and have besides a bonus of two annas per piece.

The cocoon reellers at the adjoining villages of Gonyat Gaya and Mannpur use *horeh*, a decoction of the Myrobalan nut, the fruit of *Terminalia chebula*, in reeling the cocoons; before reeling them, they boil the cocoons two or three hours in *sagi-mati* to soften them.

The reellers earn 3 rupees per month, they are provided with two meals a day, and some clothing every six months. They work seven days per week, thus earning 2 annas per day. There are 16 annas in a rupee, and reckoning

the Indian value of a rupee at 2s., an anna is worth 1½d.

After having visited the bazaars of Gaya, and seen their primitive basket and pottery making, I made the customary pilgrimage to Bodhi Gaya, or, as Sir Edwin Arnold spells the first word, Buddha. Gaya is also spelt Gya.

My visit to Buddha's shrine, and to the scene of his retirement at the Great Renunciation, was in obedience to an irresistible impulse caused by reading and re-reading Sir Edwin Arnold's "Light of Asia."

"Thou, who wouldst see where dawned the light at last,
North-westwards from the 'Thousand Gardens,' go
By Gunga's valley till thy steps be set
On the green hills where those twin streamlets spring,
Nilaján and Mohána; follow them,
Winding beneath broad-leaved mahúa-trees,
'Mid thickets of the sansar and the bir,
Till on the plain the shining sisters meet
In Phalgú's bed, flowing by rocky banks
To Gáya and the red Barabar hills."

"Near it the village of Senani* reared
Its roofs of grass, nestled amidst the palms,
Peaceful with simple folk and pastoral toils.
There in the sylvan solitudes once more
Lord Buddha lived, musing the woes of men,
The ways of fate, the doctrines of the books,
The lessons of the creatures of the brake,
The secrets of the silence whence all come,
The secrets of the gloom where to all go,
The life that lies between."

Light of Asia.

The great tower-temple, the *pípāl* tree under which he sat, his five years of meditation, the ruins of a sublime past architecture, the pilgrimage of thousands annually to this shrine, I must not here describe.

Let it suffice me to say that this great land of the tussur silk teems with interest, and calls out for the encouragement of Imperial attention quite as loudly as do also the requirements of the smaller and more valuable silkworms now perishing with diseases in the old East India silk districts.

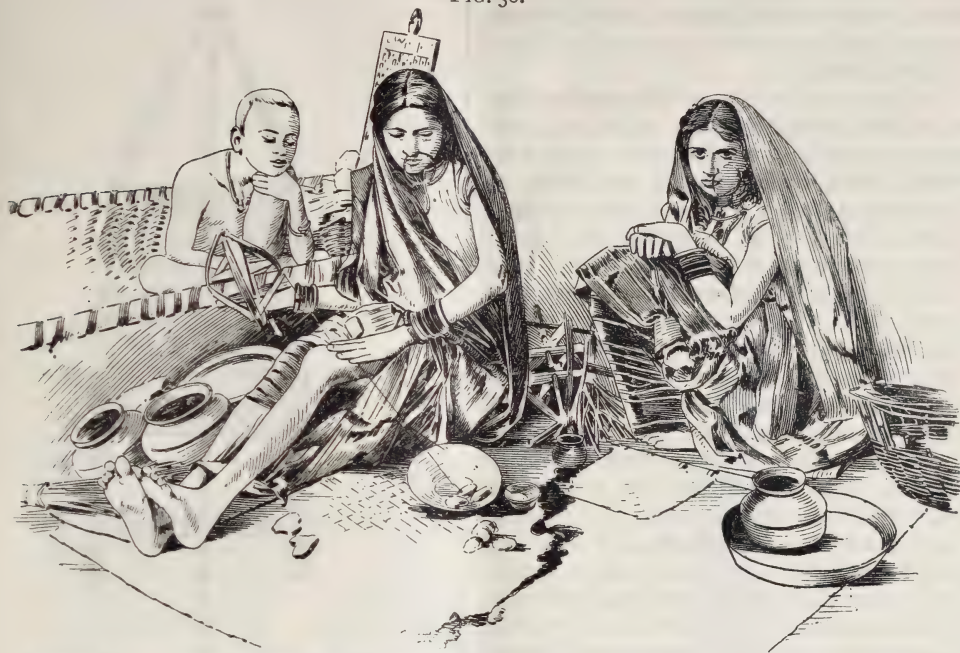
ARRAH.

My visit to Gaya being ended, I went to Arrah, and I will now say a few words about my visit to that place.

Arrah is a municipality in the Shahabad district, in Bengal, a few miles south of the Ganges, with a population of between 40,000 and 50,000—30,000 of whom are Hindoos, and the rest Mahomedans, with about forty Christians. It is 196 miles from Calcutta. It is celebrated from the prominent part it played in the Mutiny, when a small two-house-made garrison of twelve Englishmen—under Mr. Herwald

* Now Buddha Gaya

FIG. 30.



FUTWAH WOMEN: MOTHER, DAUGHTER, AND DAUGHTER'S CHILD; THE MOTHER REELING TUSSUR COCOONS.

FIG. 31.



FUTWAH NATIVE COCOON REELERS: MOTHER AND DAUGHTER.

Wake, an Arrah magistrate, and Mr. Boyle, a civil engineer—successfully and gallantly held their own for a week against 2,000 mutinous sepoys, until they were relieved by Major Vincent Eyre.

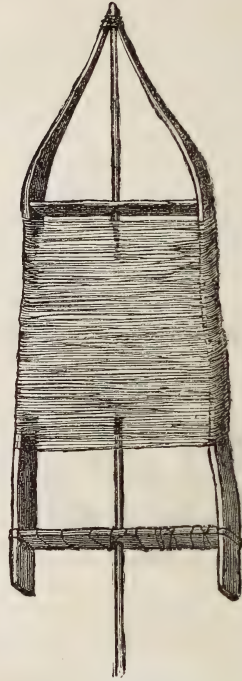
I went to Arrah to see some improved reeling apparatus, devised by a Mr. Peppe, an opium duty collector of that place, from whom I received much kindness. He was trying to establish a tussur cocoon-reeling industry there. I need say no more than that I found him producing silk of very good quality; but I thought his system rather less promising than that of the Tavelette Kellér (see Fig. 19, p. 619). Mr. Peppe was employing a woman and her daughter whom he had selected from amongst the silk-workers at Fatwah to learn to work his new reeling apparatus; the mother being a cocoon reeler, and the daughter a silk-winder. They very obligingly showed me their native methods of reeling and winding. They are very rude methods, and with very varying and more or less imperfect results. The cocoons are softened with *sagi-mutta*, an impure carbonate of soda, to which cow dung is sometimes added, and the process is then as shown in my drawing, which is from a photograph of the reeler and her daughter, taken at Arrah for me by Mr. Peppe.

Fig. 30 (p. 629) shows the native system of silk winding.

The woman gathers the ends of four, five, or six cocoons, according to the thickness of thread required. The ends are fastened to a hand-reel, like this, which is the one she was using, and it is like Fig. 31 (p. 629), but four-sided, and not flat in its frame-work, which she holds and revolves in her right hand; the threads are drawn off the softened cocoons, which rest on a dish on the floor, after the manner of unwinding a ball of worsted, and, passing over the woman's bare thigh, are rolled into one, by swift rubbing motions down the thigh with her left hand, as you observe in the drawing, and continuously wetting the threads as she rubs them with an astringent soapy decoction of the nuts of *Terminalia chebula* or *myrobalana*, which they told me fixes the thread. When the silk is taken off the reel, it is in short, dumpy skeins, like the samples which I saw reeled in this way.

The inferiority of this system of cocoon reeling to that at Behrempore, in the filatures of Messrs. Louis Payen & Co., is strikingly shown by comparing these native reeled raw silks with those reeled by their European

FIG. 32.



TUSSUR HAND REEL.

method. Fig. 32 shows the application of the European system of this work.

PATNA AND FATWAH.

From Arrah, I went to Patna, with Mr. Peppe. Patna is a city, and is situated on the Ganges, a little east of Arrah. It has a population of upwards of 170,000, 74 per cent. of whom are Hindoos. It is celebrated from the massacre which took place there in 1765, and for the prominent part it played in the history of the Mutiny in 1857. The city has a very primitive and un-English aspect, many of the roads or streets being mere mud paths, only three or four feet between the mud houses.

But, as we could find but very little trace of tussur reeling or weaving here, we took train, and went on to Fatwah, a town on the Ganges, of about 12,000 inhabitants, but seldom visited by Europeans. We were told we were the first Europeans who had ever entered the tussur houses. The townspeople regarded us with great suspicion, fearing an interference with their industry. We were followed about by a large crowd, who threw stones into one of the compounds we visited, and had it not been for Mr. Peppe asserting his Government authority, I do not think we should have escaped without injury. In one of them we saw the household

priest making red and white clay idols, for family worship. Here, I found a considerable tussur trade, and I was much interested with my visit.

I saw the stores of several tussur cocoon merchants, who collected tussur cocoons from the neighbouring jungle villages, and either sold them to reelers, or, as in several instances, employed women to reel them in picturesque single story compounds; with an open square

of about ten yards, containing large heaps of tussur cocoons, and bounded on all four sides with sheds or verandahs supported on very handsomely carved teak pillars, in which sat the women, who were reeling the cocoons by hand exactly in the manner shown in the drawing of the Arrah women. After seeing the method, and pointing out to the merchants the improved Italian method by the tavelette I took out with me (Fig. 19),

FIG. 33.



COCOON-REELING TABLE (EUROPEAN SYSTEM).

A. Bassine. B. Furnace. C. Filière. D. Tavelette Keller. E. Winding frame. F. Reel.

I visited the weavers, who were weaving cloths of tussur silk warp and cotton weft. The warp is termed "Tarni," which means to pull, and the weft or shule "Burni," which means to fill. Their name for shuttle is "Durni." Fig. 34 (p. 632) shows their "tarni" twister, and Fig. 35 (p. 632) their "burni" quills, or bobbins. The cloths are mostly woven in plaids; I bought several pieces. One of the cocoon merchants told us that 25,000 rupees

worth of cocoons passes through his hands yearly. The native uses of Indian tussur are various. The cocoons are used in some districts, when cut into strips like peeling an apple, for tying matchlocks, for tobacco-boxes like this one, for jingle bells, as in this wood-cutter's knifebelt from the Kolabar district, for Chadars, Dhotti's, and other woven fabrics, wholly or in part tussur, like these from Behrempore and Gaya.

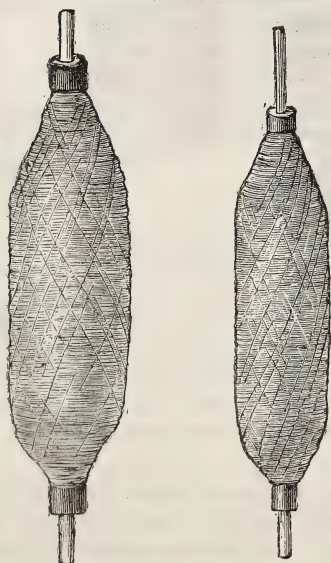
PRESENT EUROPEAN USES OF TUSSUR SILK.

In describing the present European applications of this jungle fibre, it is necessary to guard myself from being misunderstood. I do not intend to sing pæons of praise in favour

FIG. 34.



FIG. 35.



shall I be considered a mere enthusiast. The facts which I have to describe, and to illustrate by the interesting series of exhibits before you will speak for themselves, and will assert better than words the splendid results of efforts made by manufacturers in various parts of Europe to utilise this silk, so that it could present itself to good advantage. The truth, however, must and ought to be told about it. A sceptical world must be shown that to those who persevere nothing is impossible. I do not, however, wish it to be considered that I think this wild silk is destined to displace the more refined and beautiful round fibre of the *Bombyx mori*. It cannot, and if it could, I hope it never would.

But it must be admitted there are many purposes in which, if applied in such a manner as to suit all the requirements demanded of the fabric and by the user on the score of economy and the prevention of useless expenditure, which is thrift, it becomes a duty to use the less expensive material.

The old prejudices against the utilisation of tussur silk are fast passing away, and manufacturers who looked upon it doubtfully, and even with strong prejudice, a few years ago, are now bound to admit that fabrics spun or woven from the waste of this silk, are products of such superiority and beauty as to have utterly upset their ideas as to what could be produced from it. Take the case of seal-plush alone, and see what a charming product it is. Lighter, more lustrous, durable, and more healthy to wear than sealskin, it is a marvelous fabric. Yet it is made out of the waste, or short ends left from the various operations of the manufacture of tussur silk. It is to tussur silk exactly what spun silk is to the ordinary silk of commerce. It is, in fact, tussur schappe. Here are examples:—First, of the reeled tussur; secondly, of the tussur waste; thirdly, of the yarn spun from the raw and from the waste by Messrs. D. and J. Broadwell, Congleton; fourthly, the same yarn dyed; and fifthly, the velvet or plush-piled fabric, so extensively used during the last few years for ladies' over-mantles, and called seal-cloth. It is soft as fur, and quite as durable.

My wife has worn a dolman made of this material for several years, and it is now almost as good as it was at first. Being porous, this cloth does not repress perspiration, whilst a garment made of skin is not without its dangers. Besides, the skill educated in reeling, spinning, weaving, and the

of it, nor shall I praise it for praising's sake. Nor after all these long years of working for it, and of seeing it at last so successfully applied (as I can show you something better than the coarse native woven cloths which I have described and shown),

cutting of the deep pile which has been brought to such great perfection; besides, the dyeing of it in the piece, afterwards finishing it by elaborate machinery, so that the velvety appearance and the erectness of the pile shall be so perfectly maintained, is most praiseworthy, and I consider it a marvel of manufacturing skill and cheapness. For some time its price was more than £2 a yard, and even as high as £3, but now tussur seal-cloth of this excellent quality can be bought in the shops at 14s. per yard, 54 inches wide.

So extensive has this branch of industry become in Yorkshire, that sufficient waste tussur could not be procured, and enormous quantities of reeled raw silk tussur have been used. Thus, a most surprising anomaly has for the first time in the history of silk-manufacture in any country occurred. Raw silk has been obliged to be purposely made to supply this demand, that is, that tussur cocoons which have been reeled into raw silk have had to be cut up in that state into short lengths like waste, that is, to reduce the length of the fibres from a long continuous thread into short pieces of a few inches only, so that they could be carded and spun like cotton and wool into the yarns necessary to be woven into seal cloth.

So here is a unique example of a silk which, in the reeled state, is worth 4s. to 5s. per pound, in order to supply a demand, has to be first reduced to the state of waste, to a value of 1s. to 2s. per pound—the price of tussur waste—because of the persevering efforts of manufacturing skill to carry to the furthest limit the utilisation of a fibre which, twenty-five years ago, every one looked down upon with contempt, and condemned as utterly useless; so much so, that I well remember, when I first conceived the idea that, owing to the greater thickness of the fibre of tussur silk, it would be more suitable for pile-stuffs than ordinary silk, and that in a plumose form might be found its most likely destiny and its best application, I applied in vain to several English manufacturers to try it as a velvet or plush, but to no purpose. Each one thought my ideas visionary. The idea of the measuring of the diameter of a fibre had never entered into a manufacturer's head; the furthest his practice would carry him was to discriminate between the various sizes and thicknesses of "raw silk," which, as you know, consists of a bundle of many ultimate fibres. Each one I appealed to turned a deaf or derisive ear to me; some laughed at me; others said it was

quite impracticable to make anything of that rubbish, it had often enough been tried before. But my conviction was not so easily cured. I took a quantity I had dyed black to Crefeld, in Rhenish Prussia. The first manufacturer said he had tried before; it was no use attempting to weave it into velvet. I went to another, and asked him if he would manufacture it into a velvet for me, and I would not only be content with the result, however it might turn out, but would pay him for manufacturing it.

The result, for a first trial, was highly satisfactory, and I have here a small piece of this original product. At the Paris Exhibition and afterwards, Sir Philip Cunliffe-Owen was taking an interest in my efforts, and he placed this piece in the South Kensington Museum, where it has been for many years. He also had it placed, with other utilisations of tussur and other Indian wild silks, in the Indian Section of the Paris Exhibition of 1878. I believe this specimen of tussur-silk velvet to be the first ever made of a plumose fabric from this species of silk. It was made about the year 1872.

Very soon after, the Yorkshire spinners took it up. One firm, seeing my Crefeld example in the South Kensington Museum, wrote to me that he did not believe it was tussur silk, and asked me for a pattern of it, saying if it was really tussur silk they could use large quantities. I sent them one, and in a few years they had made a prosperous business in the manufacture of seal-cloth.

Tussur silk has properties superior to ordinary silk for plush purposes, where length of pile is required. Ordinary silk is too soft, and the pile flattens with the touch. This is simply owing to the respective sizes of the fibres, Tussur silk fibres, as I have already stated, are about the 750th of an inch in diameter, whilst that of the *Bombyx mori* of commerce is the 2,000th of an inch.

The strength of the bave or double fibre of tussur silk is $12\frac{3}{4}$ drams, with a tension or elasticity in a foot of 4.4 inches. The strength of the bave of Italian silk is $6\frac{1}{2}$ drams, the tension or elasticity 36 inches.

I remember the prejudices the tradesmen formerly had against its introduction. Some years ago I went into one of the principal shops in Regent-street, to purchase some tussur seal-cloth. I was told the demand for it was very limited, and that it would never prove a success; they had discontinued buying it because one lady had bought a cloak of it from them and had returned it, saying that she found that her husband putting his arm round her

left the impression of his arm on the plush. I replied that my wife had worn one for some time and I had never noticed that defect, although I had been guilty of the same practice. I said I thought the impression left was on the heart and not on the garment.

But a widespread introduction of it soon followed, notwithstanding that supposed fatal objection, and its use became world-wide, and it is really a *fabrique de luxe*, and a beautiful example of the triumph of manufacturing skill and perseverance. The continuity of its use varies of course with fashion; but it is astonishing to gather from silk statistics what an enormous quantity of the waste and raw of this silk has been consumed for this purpose: waste, which Mr. Clayton, a large Halifax spinner, stated in this room in 1879, at the discussion on my paper on "The Wild Silks of India," lay, four or five years before this date, in the Lower Thames-street Docks as a useless and untried product, and no one would look at it. From thence it was taken to Manchester, where it lay neglected for two or three years, when he accidentally came across some samples of it, and ultimately succeeded in spinning it into yarn, from which was made the seal-cloth I have been describing, which, at the time Mr. Clayton was speaking, had become so much in demand as to cause him to say at that meeting, that as the China supply had ceased, there being not a bale left, unless those interested in Indian produce could cause the waste to be collected there, the industry would die out for want of raw material.

With regard to the substitution of reeled tussur for tussur waste for seal-cloths and their values, Mr. H. T. Gaddum gives me the following information which is worth recording:—

"Up to the last months of 1883 tussah waste silk was worth from 6d. to 10d. per lb., and was made into a low-priced yarn for the manufacture of a variety of different goods requiring a glossy, cheap silk. When the import began I do not know. About the period indicated, it was found that with this material a very good imitation of the material sealskin could be produced, and a large demand for it at once arose, causing the price to advance from 10d. to 2s. 3d. This great advance was followed in the succeeding two years by a reaction to about 1s. 6d., but towards the beginning of 1887, imitation sealskins having come largely into use, especially in America, a sharp recovery occurred, and all the material obtainable found ready purchasers at from 2s. 9d. to 3s. 3d.

"The stocks both here and abroad were cleared out

towards the close of 1887. Tussah nett silk having declined to 4s., it was discovered to be at this price cheaper than the waste, and it came in consequence largely into use. It was driven up to about 5s. to 5s. 3d. for use as a waste. The production of the imitation sealskins was rapidly overdone, the demand for them at the same time fell off, and prices since then steadily declined, so that the silk is worth to-day for dressing purposes about 3s. 4d. to 3s. 6d., and the waste to 1s. 2d. to 1s. 3d."

I am not going to say that tussur reeled silk is better than the ordinary reeled silk, which nothing yet discovered can surpass, or will ever surpass; but there is but little difference in lustre between them; and there are some cases in which tussur silk is made to possess the greater lustre.

EXAMPLES.

TUSSUR PILE FABRICS.

Amongst the large series of tussur silk utilisations which I have collected for illustrations to this paper, I wish to direct your notice to the beautiful pile fabrics, seal-plush, seal-cloth and sealette, very kindly lent by several of the principal Yorkshire manufacturing firms:—

Messrs. Norton Brothers & Co., Norton-thorpe and Cuttlehurst Mills, Huddersfield.

Messrs. Joseph Walker & Sons, Lindley, near Huddersfield.

Messrs. Field and Bottrill, Skelminthorpe, near Huddersfield.

Nothing in any fibre has ever been made to exceed these. They are wonderfully rich, soft, and glossy.

TUSSUR EMBROIDERY SILK.

Tussur silk is more lustrous than Japan silk, but not quite so lustrous as China silk. One of its successful uses is for embroidery. This applied use for this silk was found for it, for the first time in its history, I am happy to say, by my wife; and this use has every appearance of being as lasting as the silk itself, for it finds an increasing use for artistic work all over the world; yet I am far from saying it is as good for embroidery as the best silk: all I say is, that it is better than spun-silk; and it has an individuality of its own, as you will easily observe by these beautiful specimens of embroidery, kindly lent by the Leek Silk Embroidery Society, all of which, with one exception, is worked in Indian tussur silk. In one of the cases is a collection of Indian tussur silk embroidery-floss, dyed in various colours with Eastern dyes by myself. This will indicate the kind

of thread used by the society, also the colours used. Next to this is a case containing a variety of styles of fringes for embroidery, altar-cloths, and other purposes, entirely made of Indian tussur silk, such as are used by the same society.

TAPESTRY CLOTHS AND CURTAIN STUFFS.

The employment of tussur silk in England and Scotland, and its successful substitution for ordinary silks for upholstery cloths, or tapestry, as it is erroneously termed, has been very large during the last seven years. It

FIG. 36.



EMBROIDERY OF INDIAN DESIGNS—LEEK EMBROIDERY SOCIETY.

admirably lends itself for giving effect and brightness to these goods, which are mixtures of cotton or wool with the floral parts of tussur silk. I believe these manufactures have fallen off with us of late. I find, however, that the manufacture of these fabrics is somewhat

rapidly increasing in Lyons, as the extraordinary statistics prove. I attribute the British decadence to the tendency we invariably have in all our manufactures to cheapen them at the expense of excellence and beauty; and to do this, something must be omitted, to

make the goods cost less, to satisfy the bargaining of the merchant, and the lamentable price competition almost enforced upon manufacturers. In France, the converse is the case generally. Being an artistic people, they realise the force of Matthew Arnold's words:—

"Art still has truth;
Take refuge there."

One has only to look at these very beautiful brocatelles lent by Messrs. Kendal, Milne & Co., of Manchester, the tapestry cloths of Messrs. D. Barbour and Co., the charming and unsurpassed tussur silk brocades of Messrs. Devaux and Bachelard, and Messrs. Lamy and Girand, both of Lyons, and the rest of this unique collection, which I will briefly describe presently. The large blue, gold, and green curtain exhibited under the arch, is one I had manufactured in Scotland some time ago. The design is the one from the Caves of Ajanta.* The blue and green parts are woollen, and the gold birds are an enrichment in tussur silk. A complete catalogue of all these will be found at the end of my paper.

TRIMMING MATERIALS.

The various articles for trimming purposes I have had so kindly lent by their respective manufacturers to me for this paper, prove the superiority of this silk even over any other for these purposes, in the way they are applied, by reason of the natural lustre of the silk, its cheapness, and its greater resistance and firmness in pile.

May I draw your attention to the beautiful specimens of tussur silk utilisations for trimming purposes, such as umbrella-tassels, muffs, upholstery tassel-fringes, parasols, furs, hats and bonnet-tassels for women and children, pom-poms, chenille, dyed tussur silk on bobbins, &c., lent by the following firms:—Messrs. A. Kerr and Co., 59, Florida-street, Bethnal-green-road, London, E.; Mr. A. W. Metcalf, 22, Nicholl-square, London, E.; Messrs. E. Bateman and Co., Limited, Tottenham-court-road, London. *German*—Mr. L. Abrahamsohn, Berlin; Messrs. Schlottmann and Co., Berlin; Messrs. W. and G. Kessler Berlin.

Many of these trimmings are very tastefully wrought; some in shaded dyes in chenille; some, chenille and tram alternating, and

* This pattern is a reproduction of a portion of the fresco paintings in the caves of Ajanta, in the province of Bombay. These caves were Bhuddist places of worship, and the paintings are admirable for their beauty of design; both borders and subjects being exquisitely drawn. They were painted about 2,000 years ago.

others, chenille intertwined with bright gimp tussur cord.

Messrs. Anderson, Lawson and Co., of Glasgow, have sent two most interesting tussur chenille table-covers, with chenille fringes. This is a most recent and important utilisation, as a very large quantity of tussur silk is required for each cover. The surface is very velvety, showing beautiful reflections of light, and the utilisation is certain to become popular.

HANDKERCHIEFS.

Amongst the rather unlikely uses for tussur silk, I see it has found its way into the pocket-handkerchief branch of the silk industry. From Berlin I receive this small lady's *mouchoir* with border in the approved fashion and embroidered initials. It is remarkably well made, very even in texture, and neither hairy nor hard, and it is, moreover, almost a pure white. It was sent to me by Mr. Maas, and its value is 2s. 3d.

He also sent me these small samples of well-woven tussur thin cloth of various textures, and undyed, he informs me they are used for dust-coats, both for the home and export trade.

I have the following reliable information from Germany. The most important silk manufacturer in Crefeld has tried tussur silk for ladies' dress goods, but when the experiment promised a successful and practical issue, he found out, to his disappointment, that he could not contract with dealers for quantities at settled times, and was thus unable to take orders for goods of fashion, the correct and fixed time of delivery being the most essential condition.

The next is a piece of cream-coloured figured damask, quite rivalling the best weaving of Lyons. It is made wholly of tussur silk, and there is also a specimen of gold-coloured damask of the same pattern, I am glad to say of English manufacture. Both of these, made and lent by Messrs. M. Perkin and Sons, 27, Curtain-road, London.

Here are also three excellent and lustrous examples of Indian tussur silk figured damasks, in various colours, in an Indian design. They were woven for me in Leek for my Society of Arts paper in 1879, and I believe were the first figured fabrics ever made in Europe entirely of tussur silk.

The two French-made open-work damasks, are for light dress purposes, and are of Indian tussur silk.

Detailed lists of these will be found in the

catalogue of illustrations at the end of the paper.

TUSSUR CARPETS AND RUGS.

I have tried successfully the application of tussur silk to carpets and rugs. From its greater thickness of fibre it produces a result between the silk carpets of India and Utrecht velvet. Here is a hand-made example designed by Mr. William Morris, and made for me by his firm. Also several others of smaller size. It is quite as lustrous as the Indian silk carpets, and has a better and firmer pile.

Here are several specimens of tussur velvet made recently by Messrs. Devaux & Batchelard, of Lyons, some of which I have dyed in the piece, and others I have printed. They are admirably suited for furniture velvet, being more lustrous than Utrecht velvet, and not so soft as ordinary silk velvet.

Here are some beautiful woven summer curtains and shawls with very effective borders and centres, manufactured and lent by Messrs. A. Jamieson & Co., Darvel, Ayrshire.

Messrs. J. W. and C. Ward, of Albion Mills, Halifax, have been obliging enough to lend me two of their light tussur silk summer curtains; both colours and patterns are disposed with great taste.

INDIAN TUSSUR SILK.

But it is in France that Indian tussur silk to-day finds its greatest market and manufacturing use, and the reason is easy to see. China raw tussur silk is so badly reeled as to be fit only for the coarsest textiles; but since the time I was in India, so much attention has been paid to improving the reeling of this silk at the Behrempore and Surdah filatures, as also at Arrah and at other centres, that an Indian raw silk is produced such as can be successfully used for artistic purposes in upholstery by the best Lyonesse manufacturers, of whom, probably, Messrs. Lamy & Giraud and Messrs. Devaux & Bachelard, and Messrs. Viallar, Guèneau, and Chartron, have been the most persevering and successful. Messrs. Devaux and Bachelard, of Lyons, have kindly lent me two charming specimens of their manufactures, in which Indian tussur silk is used for the weft or shute; the warp is of ordinary silk.

The pale old-gold coloured satin-damask, with pink and pale yellow flowers and graceful other treatment, is one of the handsome results of weaving and effect in the whole collection. The fabric is very thin, and falls in

graceful folds. The other specimen is a thick fabric, suitable for hangings or waistcoats, covered with typical Indian shawl or pear pattern.

In the Exhibition of 1889, at Paris, my duties in the silk section caused me to notice in it some interesting but plainer fabrics, manufactured by Messrs. Viallar, Guèneau, and Chartron, of Lyons. One of the partners obligingly gave me two specimens which are here exhibited; one is a red plaid, with undyed but bleached tussur ground, the other is a black plaid, with unbleached tussur ground. They have also been kind enough to send me a series of nine other fabrics in which tussur mainly forms the whole. They are, as you see, in plaids and stripes, except one, which is of plush *rayé*. These fabrics are all manufactured from Indian tussur raw-silk, reeled at Berhampur by Messrs. Louis Payen, *filateurs* at that place (who inform me they have recently reeled more than 50,000 kilogrammes—110,000 lbs.—of tussur silk), as well as large throwsters in Italy and France. Here are samples of their tussur raw-silk, as clean and almost as fine as Italian silk.

This important filature I found under the able and energetic management of M. Gallois, who was then commencing to reel tussur cocoons. I am informed, from Berhampur, that this firm, since I was there in 1886, have added three large filatures, and are building a fourth, with a fifth in contemplation, so much has the demand for their Indian tussur silk increased.

And it is from this raw silk that the beautiful fabrics which I am about to point out to you are made. Messrs. Lamy and Giraud have been good enough to furnish me with specimens of their art-furnishing stuffs, of one metre each. As you see, they are beautiful brocades, of which all, or nearly all, the ornamental parts of flower and foliage treatment are of tussur silk, dyed at Lyons, in very harmonious and rich shades of colour. In those charming brocades, tussur silk is used for the weft. Messrs. Lamy and Giraud inform me that Indian tussur silk gives excellent results in a large range of these fabrics, when properly dyed, the effect being undistinguishable from real silk, especially in the cream grounds. The warp is of cotton, the tram of Indian tussur silk.

Thus you see here at least two most important improvements have been effected, which have elevated the use of tussur silk into a new, an unexpected, and a much more important horizon than that of its Yorkshire uses, of

which I have said so much, namely, by improvements in reeling, improvements in dyeing, and its consequent amelioration to permit of its being used by the highest class of Lyons manufacturers.

OPERA-SHAWLS.

Besides the application of tussur silk to weaving, I am pleased also to be able to show that elegant and effective work can be done in hosiery and lace manufacture. Observe the case of three opera-shawls, or fichus, of machine-knitted or hosiery-made tussur silk, unbleached, manufactured by Mr. Stimson, of Leicester, who is well known for his successful applications of this silk for light shawl purposes.

This silk is made from Indian tussur silk, thrown by Messrs. J. and T. Brocklehurst and Sons, of Macclesfield, who have been kind enough to lend me a bundle of it. It is three-threads orgazine, of most excellent quality, and beautifully thrown. It is also used in the exhibits of lace and elastic webs. The Berlin fichu manufacturer has had the courage to go a step further in this direction, by having the tussur silk bleached. This gives a very light and pleasing appearance to the fichu; and I think Mr. Stimson would do well to follow in this direction, especially as it would add to the variety he makes. It is this cream-coloured specimen, and is lent by Mr. William Mass, of Berlin. The price quoted in Berlin is 10s. I am informed from the same source that tussur silk products are exported from Berlin to America in rather important quantities. It is difficult to ascertain the extent and variety of their tussur silk goods, but it is used for dresses, shirts, pocket-handkerchiefs, dust-cloaks, and shawls, for both home and foreign markets, and also in Saxony, where lace, gloves, &c., are made of it.

LACE.

To show how the use of tussur-silk is now beginning to permeate silk manufactures, it is pleasant to be able to bring forward such well-designed and well-manufactured specimens of lace as those in the two cases I now point out. These are manufactured and lent by Messrs. J. Kirkbride and Co., St. Mary's Gate, Nottingham. All the ornamental treatment has been done with Messrs. Brocklehurst's orgazine after being dyed black, its lustrous appearance proving it to be very suitable silk for this purpose.

ELASTIC WEBS.

Messrs. Archibald Turner and Co., Bow Bridge Mills, Leicester, have also utilised this silk for elastic webs. Here are specimens of their pocket-book and garter webs, which they have kindly lent to me for this paper.

PRINTED TUSSUR SILK.

To show what can be done with tinctorial matter in printing upon tussur silk, I have printed a series of large examples upon native woven Indian tussur silk. Some of them are on bleached grounds, and others upon unbleached grounds. I think you will agree with me that they are not unsuccessful, and are very suitable to be worn for dress.

DYES TO GEM-COLOURS.

To show the receptivity of tussur silk to tinctorial matter under the present improved methods, I have here a case of fourteen colours dyed by my son to the shades of the principal precious stones, as follows:—Sapphire, emerald, topaz, pink topaz, spinel-ruby, beryl, jacinth, chrysoprase, amethyst, coral, gold-quartz, turquoise, ruby, peridot.

It will be seen that the difficulties of dyeing this silk may now be considered to have been entirely overcome, excellent results being obtained abroad, by Messrs. Bonnet, Ramel, Sevigny, Giraud, and Marnas, of Lyons, and by other Lyons dyers; by Mr. W. Spindler, of Berlin, and by most good European dyers, English and Continental.

The two cases below are filled with tussur raw-silk such as is used for the manufacture of pom-poms, dyed by my son with aniline dyes, containing examples of tussur undyed raw-silk as imported; also after bleaching and dyeing into a variety of pale shades suitable for this purpose. There are examples, also, of the purest whites and blacks attainable on this silk.

EMBOSSING WITH TUSSUR SILK.

Here are three bottles of powdered or very finely-cut tussur silk of various colours. This powder, by a patent process, is used for embossing or partially surface-coating it upon plain cloths in the form of figures, flowers, &c. It gives the cloth the appearance of woven velvet on a plain surface. I have not been able to obtain specimens of the cloth so treated, owing to the novelty and secrecy of the utilisation, but I believe it is in operation at Roubaix.

CONCLUDING OBSERVATIONS AND STATISTICAL RECORD OF CONSUMPTION.

It is thus the dictum of European manufacturers of 15 years ago that tussur silk could never be made anything of, that it would never replace the ordinary silk of commerce, has been returned to them, for here are examples so rich and so beautiful that none but experts could discover what silk they are made of, and it may now be asserted that its day has arrived; that it can and does in a very important degree, for these purposes at least, take the place of the more costly silks of France, Italy, China, and Japan. I never presumed to assert that its mission was to substitute itself for these silks, but I modestly did assert that it would, in time, prove to have distinctive uses, that no fibre comes to us for uselessness, but that with attention uses can be had for all. The triumph of successful tussur silk manufacture is complete. The fibre takes high rank, and can be and now is very largely used to economise the cost of artistic and very beautiful cloths, so as to place them more within the reach of people with moderate incomes, and it has had also this effect, that it has helped to keep down the price of the ordinary silks, and so has permitted them to have a wider distribution. Italian silks are now less than 20s. per pound, and were never known to be so low in price. The Government of France has acknowledged the influence of tussur silk recently, for at a meeting of the committee on French industry, held in Paris the other day, at which M. Fougierol, one of the ministers of the French Government, and a member of the Chamber of Deputies, said that tussur silk ought to be taxed, as people were much guided by price, and that was so especially in the increasing use of tussur silk in France, and M. Berenger, President of the General Syndicate of French Cultivators, and Member of the Senate, supported him, saying that so far as tussur silk was concerned, it ought not to be made an exception, it must not be permitted to enter duty free, because to do so would be to increase the use of this silk, which is an inferior sort, and that would be to the prejudice of the French producers.

I hope I may be permitted, with not a little pardonable pride, now to assert the triumphs and gradual progress of this very interesting silk to which I have devoted myself for so many years, sometimes hoping against hope, and at times almost despairing of ultimate success; and in leaving it at this successful stage of its history I wish it further success,

and that India may in the long run be the nursing mother of its European requirements.

In 1878, the Government of India were anxious that the promising developments of tussur silk uses should be shown in the Indian Section of the Paris Exhibition of that year, and requested me to place myself under the guidance of Sir Philip Cunliffe-Owen, in forming an interesting collection. Sir Philip entered into the spirit of the undertaking most cordially, and gave me every help, and, since that time, has shown the greatest interest in this Indian silk; and great credit is due to him for the energy with which he assisted in arresting the attention of the French, in 1878, and the English, at the Silk Culture Court of the Colonial and Indian Exhibition, in 1886; in fact, the success of the increased use of tussur silk is greatly due to him.

He occupied the chair at the reading of my paper on the "Wild Silks of India," in this room, in 1879, and said, in introducing me, that the evening's subject was one of the practical results of the Paris Exhibition, and that there was nothing which interested the French people more than the collection of Indian silks. He further stated, that the Lyons manufacturers saw the importance of it, and were greatly interested. Since that time, those observations have been attended with abundant realisation, as I will now proceed to show.

During my jurorship at the 1878 Paris Exhibition, I had many inquiries respecting the vitrines containing the collection of the wild silks of India, from French manufacturers; and the cases were frequently opened for their examination. Several were at first disinclined to believe they were really tussur silk, and their doubts were only removed by such personal examination. Monsieur David, the largest ribbon manufacturer in St. Etienne, and also one of the silk jury, said there was no doubt as to a successful future for it, and that he could see his way to use very large quantities; and this opinion was expressed to me by several other French manufacturers of importance.

The attention of the French manufacturers was roused, and, very soon after that exhibition, the Chamber of Commerce of Lyons did me the honour to ask me to contribute a collection of tussur silk utilisations, similar to the one exhibited in the Indian Section of the Paris Exhibition. I sent them a very large and specially prepared collection, which they placed in their Industrial Museum, at the Bourse in Lyons, where it now is, and is named the

“Wardle” collection. At that time tussur silk found little or no utilisation; to-day the consumption is very large, as I will now proceed to show.

QUANTITIES USED NOW AND FORMERLY.

On April the 9th of this year, Messrs. Louis Payen and Co. wrote me that the following figures represent the quantities used in Lyons last year:—

The Conditioning House registered for 1890 a total quantity of 306,152 kilogrammes, or 673,534 lbs., of tussur silk, thus divided:—Organzine 13,347 kilos or 29,363 lbs.; Tram 69,028 kilos or 151,864 lbs.; Raw Tussur 223,776 kilos or 492,307 lbs.

This is an average of 92 bales of 140 lbs. each per week, and it is confirmed by the Chamber of Commerce published report of last year. Compare this with the whole year of 1879, when only 53 bales or 7,420 lbs. were imported, and they certainly were not all used.

For the week ending April 11th last, Lyons capped its record. It received and conditioned 136 bales of tussur silk, or 39,040 lbs., against 178 bales or 39,160 lbs. of silk of French growth, and 38 bales or 8,360 lbs. of Italian silk for the same week.

Surely this is a most surprising realization of what so recently as 1876, or 15 years ago, was only an idea, for in that year only 175 bales reached Europe. I think it will be conceded that it is a consummation which the most ardent imagination could scarcely have been sanguine enough to hope for.

The following Table will explain this statement in a clearer way:—

Three silks conditioned in Lyons for the week ending April 9, 1891.	No. of bales.	Weight per bale.	Total weight in lbs.	Weight in lbs. less than tussur.	Weight in lbs. more than tussur.
Tussur	136	140	39,040	—	—
French	178	220	39,160	—	120
Italian	138	220	8,360	39,680	—

Thus the quantity of tussur comes within 120 lbs. of silk of their own growth, whilst it beats that of Italy by no less a quantity than 38,680 lbs.

The quantities of the silks of other countries conditioned in Lyons in that week will be found in the official report in the “Bulletin des Soies et des Soieries” for April 18th, 1891.

Messrs. Louis Payen & Co. go on to state

in their letter “that tussur silks (both Indian and China) are used in Lyons in a great many different sorts of textures, interwoven with other kinds of silk, and wool, and cotton. Trimmings, lace and *chenille* use it very largely. We send you by post two skeins of our Indian raw silk which we are making ourselves in our Bengal factories in large quantities. 40,000 to 50,000 kilogrammes yearly, or 88,000 to 110,000 lbs., and which we can sell at the following prices:—

21 frs. for 30/40 deniers per kilo., or 7/8 per lb.
20 frs. for 40/50 deniers (as the sample) per kilo., or 7/4 per 1 lb.
19 frs. for 60/70 deniers per kilo., or 6/11 per lb.”

These prices are at Lyons on conditions at 90 days, and free of Lyons.

I have been informed by the President of the Lyons Chamber of Commerce that the consumption of tussur silk and tussur silk waste in France during the latter half of the decade 1870 to 1880 is as follows:—

During 1876, 1877, and 1878 unknown; in fact, hardly any was imported. The Chamber does not know of any. I have also consulted several important Lyons and St. Etienne manufacturers, and they say they do not remember that any branch of the silk trade then required or used any tussur silk at all. 1879—53 bales, or 7,420 lbs. of raw tussur silk; 59 bales, or 8,260 lbs. of waste tussur silk. 1880—375 bales, or 48,580 lbs. of raw tussur silk; 147 bales, or 20,580 lbs. of waste tussur silk.

The following Table shows the state of the London market in tussur silk from 1874 to 1880. Compare it with the remarkably increased consumption since the Paris Exhibition of 1878:—

Year.	Stock (Jan. 1st).	Imported.	Consumed.
	Bales.	Bales.	Bales.
1874	661	none	168
1875	494	“	319
1876	175	427	174
1877	428	1,037	284
1878	1,181	837	736
1879	1,282	58	1,142

CHINESE TUSSUR SILK.

As I have previously stated, the Chinese being quicker to respond to commercial requirements, as soon as they saw the steadily increasing demand for Indian tussur silk in Europe, immediately turned their attention to a greatly increased production of their own article, and to them for some years, say since 1884, has been owing the bulk of the supply of raw and waste tussur silk for European wants.

That India, too, has not been altogether lethargic in an increased output of tussur raw silk, will be shown further on, whilst in regard to Indian-native-woven tussur fabrics, she has greatly increased her productions and exports.

To show how much the tussur silk trade has increased in China since 1879, the following highly suggestive figures will show. They are copied verbatim from the Chinese Customs Report :—

“Shipments of raw silk, waste silk, and pierced cocoons, from the provinces of Manchuria, Chili, and Shantung, for the ten years ending 31st December, 1888.

1st Jan. to 31st Dec.	lbs.
1879	169,496
1880	671,566
1881	886,766
1882	909,033
1883	728,666
1884	2,043,600
1885	1,796,400
1886	3,189,100
1887	3,375,500
1888	2,874,766

The enormous increase in this business is mainly due to the application of tussur spun silk to the seal and plush trades.”

It may be well to place upon record the present values of the various kinds of silks, European and Asiatic, of commerce and tussur silk :—

	s.	d.	s.	d.	
China	13	6	to	15	3 per lb.
Canton	9	6	„	12	6 „
Japan, No. 2	15	0	„	15	6 „
Japan filatures	16	0	„	17	0 good to best
Japan filatures	15	0	„	15	6 ordinary
Italian Novi	17	6	„	19	6 „
Italian Lombardy ..	16	0	„	18	0 „
British	16	6	„	18	6 „
French	19	0	„	22	0 „
Bengal, Surdah	14	0	„	15	0 „
„ Cossimbuzar {					November
„ G. G. Mc P. {					Bund.
„ Gonaten .. {	14	0	„	14	6 Bombyx
„ Ramnugger {					fortunatus.

WILD SILK.

	s.	d.	s.	d.
Tussur, Indian	5	0	to	7 8
Tussur, China	3	8	„	4 8
Tussur, Waste	1	2	„	1 6
Another quotation....	0	10	„	1 4½
Tussur pierced cocoons yielding 70 per cent. of silk	1	9½	„	1 11
Tussur Waste, press- packed for spinning	3	6		

It is very unfortunate that England is so much behind France in silk-trade statistics. I have several times memorialised the Board of Trade, both in my private capacity and also as President of the Silk Association of Great Britain and Ireland, to publish annually the quantities of silk imported of the following kinds :—

Bengal raw silk.

Bengal raw silk-waste knubs, chassum, &c.

Bengal corah silks.

Tussur raw silk.

Tussur silk-waste.

Tussur silk pieces.

But they inform me that it would be impracticable to make these distinctions without causing delay in the examination of the goods at the ports. We are also in the same state of ignorance with respect to the trade particulars of all our silk centres; whilst in France, Germany, and Switzerland all particulars are published yearly, and can easily be referred to,

The Lyons statistics show a rapidly increasing consumption of 150,000 lbs. of Indian tussur for last year for that city; but further than this I am without information. The consumption in Switzerland and Germany is considerable, whilst in the United States of America it has been very large; one house there was using 2,000 lbs. per week at the time of the Colinderies Exhibition.

INDIAN AND OTHER WILD SILKS.

I hope I have not wearied you with this tussur silk recital. It is an industry in deep water, and in taking affectionate leave of it I would say that there are yet other wild-silk worlds to conquer, and if I am spared I hope to turn my attention to at least one of three kinds of Indian silks not yet used in Europe, which are capable of having an important future. I need only mention the Eri and Muga silks, long extensively cultivated and used in Assam; the products of the caterpillars of *Attacus Ricini* and *Attacus Assama*; the Atlas silk of the *Attacus Atlas*, the largest known moth.

I found the atlas silk utilised in the Nepal Terai by the Mechi people, in the form of the rudely made cloths, of which I have brought two extremely rare and almost unknown kinds. The warp and weft are hand-spun yarns of long staple. Owing to the oppression the native weavers of this cloth have had to undergo at the hands of the Nepalese authority, they have lately been driven from that part of the country bordering on the Mechi, and have settled on land across the Teesta.

Here is also another piece made from the same silk, but showing the native dyeing in the red stripes.

They were first exhibited in the Colonial and Indian Exhibition, and are more fully described, with all other kinds of Indian silk, in the exhaustive and descriptive catalogue of the Silk Culture Court, a book which ought to be in the hands of every European silk manufacturer.

I would especially mention Muga silk, examples of which are before you in all stages. It is even superior to tussur, and is more amenable to dyeing. It only wants bringing to the front for utilisation and increased production.

MANIPUR SILK.

Here is a piece of silk which at the present moment is of interest, but the interest is of a melancholy kind. It is made by the natives of Manipur for the use of their richer people. It is in stripes with broad red pattern border.

LA SOIE CHARDONNET—LA SOIE ARTIFICIELLE : ARTIFICIAL SILK.

During my Jury duties in 1889 at the Paris Exhibition, I came across an entirely new kind of fibre, invented by Count de Chardonnet, who terms it artificial silk. But little was thought of it at the time, but it has subsequently been brought to greater perfection, as you will see from the examples I have thought right to bring up with my other illustrations, and it may be of interest to some present. It is a product which belongs neither to the animal nor to the vegetable kingdom, but is purely an organic chemical substance, formed from cotton or cellulose after conversion into gun-cotton, and from that state into collodion, from which viscous substance it is drawn up as a fine thread by a reel through a glass tube into which water is injected, which immediately hardens the fibre, when it assumes the appearance of silk, which it very much resembles, as far as lustre is concerned. It will, no doubt, command some kind of utilisation, although it can never replace silk, which is much more durable and strong. It is, nevertheless, a deeply interesting and cleverly-devised product. It is protected by several patents; and a company has been formed in France, and one is about to be formed in England. Whatever success it may have in the future, one thing is certain, that its greatest rival will be tussur silk, which can successfully compete with it in price.

Here are two cases of it: one containing it in skeins, dyed in various colours and black, by my son, who has recently found methods of dyeing it without impairing its curious lustre. The other shows it in the state of two kinds of silk damasks, the worst of them only is artificial silk, the warp being real silk, and, in a small piece of ribbon, the figured part of which is artificial silk, and the rest of real silk.

LIST OF THE ILLUSTRATIONS AND UTILISATIONS OF TUSSUR SILK.

1. Entomological glass case of arranged moths, larvæ, cocoons, and silk:—*a.* Larva of tussur silk moth, *Antheræa mylitta*; *b.* Male and female moths of *Antheræa mylitta*; *c.* Cocoons, whole, pierced and showing chrysalides; *d.* Tussur raw-silk, native reeled at Fatwāh; *e.* ditto, reeled by the Italian method by Messrs. Louis Payen and Co., at Behrempore; *f.* Male and female moths of the Chinese tussur silkworm, *Antheræa pernyi*; *g.* Cocoons of tussur silkworm, *Antheræa pernyi*; ditto, in oak leaves; *h.* Chinese reeled silk of tussur silkworm, *Antheræa pernyi*; *i.* Larva of *Bombyx mori*; *j.* Male and female moths of *Bombyx mori*; *k.* Cocoons of the mulberry-fed silkworm, *Bombyx mori*, Italian, white; *l.* Ditto, yellow; *m.* Hot-weather cocoons, *Bombyx cræsi*, and cold-weather cocoons, *Bombyx fortunatus* of Bengal.
2. Large diagram of larvæ, moths, and cocoons, natural size and enlarged, and raw-silk:—*a.* Tussur silkworm or larva; *b.* Tussur moth, *Antheræa mylitta*; *c.* Tussur cocoon showing pedicular attachment; *d.* Chinese tussur moth, *Antheræa pernyi*; *e.* Chinese tussur cocoon; *f.* Mulberry-fed silkworm of commerce, *Bombyx mori*; *g.* *Bombyx mori* moth.
3. Large drawing of native Arrah woman reeling and winding tussur silk by their native methods.
4. Large drawing of the European method of cocoon-reeling with the Italian Tavelette Keller.
5. Diagram of the microscopic appearance of tussur silk fibre, longitudinally and in section. Ditto, ditto, showing separated fibrillæ.
6. Ditto, ditto, of the ordinary silk of commerce, *Bombyx mori*, longitudinally and in section.
7. Five bottles containing silkworms in spirit:—*a.* Larva of *Bombyx mori*; *b.* Larva of the tussur moth, *Antheræa mylitta*; *c.* Larva of *Cricula trifenestrata*; *d.* Larva of the eri moth, *Attacus ricini*; *e.* Larva of the muga moth, *Antheræa Assama*.
8. Grape-like clusters of the cocoons of *Cricula trifenestrata*, from Ranchi, Chutia Nagpur, Bengal.

9. Three hand-reels, used by the natives for reeling tussur cocoons. One hand-reel, used by the natives for reeling ordinary cocoons.
10. The Italian Tavelette Keller.
11. "The Dyes and Tans of India," by T. Wardle.
12. Map of India.
13. Tussur silk dyed black, showing scintillations.
14. Convoluted flat tape of tin-plate do. do.
15. Cylindrical rod of the same material, showing equal diffusion of light.
16. Native-woven piece of Indian tussur silk-cloth, undyed. Ditto, ditto, dyed at Hazaribagh, Bengal.
17. Thirty cards, containing samples of woven silk, tussur silk, wool, and cotton, dyed with Indian vegetable dye-stuffs.
18. Santal bow and arrow.
19. Hortus siccus of the tussur food-plants, with tussur cocoons attached to the branches, collected and mounted by the Rev. A. Campbell in the Santal jungles in Gobinpoore, Manbhoom :—*a*. Terminalia tomentosa; *b*. Terminalia chebula; *c*. Terminalia arunja; *d*. Terminalia bellerica; *e*. Shorea robusta; *f*. Zizyphus jujuba; *g*. Lagerstroemia parviflora; *h*. Careya arborea; *i*. Diospyros tomentosa; *j*. Alstonia scholaris.
20. Tussur cocoons from the Santals at Pokhuria.
21. Tussur cocoons from Gaya.
22. Tussur raw silk from Gaya, two qualities.
23. Tavelette Keller.
24. Three hand-reels.
25. Hanks of native reeled raw tussur silk, reeled in Arrah.
26. Samples of tussur raw silk reeled by Messrs. Louis Payen and Co., at Berhampur.
27. Fatwah tussur cocoons.
28. Fatwah plaid cloth made of tussur silk warp and cotton weft.
29. Tobacco box of tussur cocoons.
30. Woodcutter's knife-belt with jingle-bells of tussur cocoons.
31. Tussur silk waste for seal-cloth manufacture; tussur raw-silk used for cutting up for seal-cloth.
32. Tussur silk spun into yarn for weaving into seal-cloth; three sizes, dyed and undyed, manufactured, and lent by Messrs. J. Bradwell and Co., silk spinners and merchants, Congleton.
33. Seal plush.
34. Six kinds of tussur silk seal-cloth, plain, rayé, and embossed; manufactured and lent by Messrs. Norton Brothers and Co., Nortonthorpe and Cottlehurst Mills, Huddersfield.
35. Five kinds of tussur silk sealettes, manufactured by Messrs. Joseph Walker and Sons, Lindley, Huddersfield :—*a* and *b*, two kinds of bronze sealettes; *c*, bronze ecrase; *d*, black ecrase; *e*, stripe beaverette.
36. Two kinds of tussur silk seal-cloth, manufactured by Messrs. Field and Botterill, Skelmanthorpe, near Huddersfield :—*a*, stamped; *b*, with white hairs inserted.
37. Plush made in Crefeld in 1872, the first application of tussur silk for a pile fabric, lent by the South Kensington Museum.
38. Embroideries in tussur silk, worked and lent by the Leek Embroidery Society; *a*. Dinner-table centre on satin, worked in Indian tussur silk, designed by the late John Sedding; *b*. Portière on cotton velvet, designed by T. Wardle, jun., and worked in tussur embroidery silk; *c*. Portière on tussur silk, worked in tussur embroidery silk; designed by William Morris; *d*. Panel or screen, worked on native woven Indian tussur silk, in tussur embroidery silk; *e*. Embroidery for cushion, worked on tussur, in tussur embroidery silk, *f*. Tea-gown on tussur, worked in Indian tussur silk; *g*. Design for curtain on cotton velvet, worked in Indian tussur silk; *h*. Embroidery for tea-gown on tussur, worked in tussur embroidery silk; *i*. Curtain border on tussur silk; designed by G. G. Scott, jun.; *j*. Portière, "Ajanta" design on tussur silk, worked in tussur embroidery silk.
39. Eria silk cloth, English woven; printed by Thomas Wardle.
40. Cloth made of muga silk (Antheraea Assama).
41. Bengal raw silk, 10 deniers, reeled from Bengal cocoons with the Tavelette Keller.
42. The first English-woven piece of silk from muga cocoons; printed by Thomas Wardle.
43. Muga raw silk (Antheraea Assama), reeled in the Colonial and Indian Exhibition, 1886.
44. Tussur silk reeled at Fatwah.
45. Four specimens, of 1 metre each, of brocades, the ornamental parts of Indian tussur silk, woven in patterns of Louis XVth and Louis XVIth styles; manufactured by Messrs. Lamy and Giraud, Lyons.
46. Tussur plain cloth of excellent quality for under-clothing, very agreeable to wear; manufactured by Messrs. Lamy and Giraud; width 27½ inches, value 5s. per yard.
47. Brocatelles, or tapestry-cloths, of French manufacture, lent by Messrs. Kendal, Milne & Co., Deansgate, Manchester :—*a*. Brocatelles, spun-silk warp, with the whole of the weft of Indian tussur silk; *b*. Brocatelle, spun-silk warp, with the weft of Indian tussur silk and cotton; *c*. Brocatelle, cotton warp and Indian tussur silk weft; *d*. Brocatelle, spun-silk warp, with the whole of the weft of Indian tussur silk.
48. Tussur silk tapestry-cloths, for curtains, manufactured by Messrs. David Barbour & Co., Renfield-works, Pollokshaw, near Glasgow.
49. Twelve pieces of tapestry-cloths, for curtains, the weft of which is of tussur silk of French manufacture.
50. Blue gold and green curtain, of Scotch manu-

facture, Ajanta design; the gold-coloured parts are of tussur silk.

51. Two examples of tussur tissues, manufactured by Messrs. Villar, Gueneau & Chartron, of Lyons, in plaids also; one other patterned fabrics, in which tussur forms the whole, manufactured by the same firm.
52. A series of summer curtains and a shawl manufactured and lent by Messrs. Jamieson & Co., Darvel, Ayrshire:—*a.* Gold, green, and salmon-coloured summer curtain of tussur silk, beautifully woven, with very effective border and centre; *b.* Gold and salmon-coloured summer curtain, interwoven with muslin; *c.* Light richly-coloured shawl.
53. Two tussur silk summer curtains, manufactured by Messrs. J. W. & C. Ward, Albion-mills, Halifax.
54. Small example of gold-coloured damask, manufactured by Messrs. M. Perkin & Sons, 27, Curtain-road, London, E.C.
55. Example of cream-coloured, figured damask Indian tussur silk, manufactured by Messrs. M. Perkin & Sons, 27, Curtain-road, London, E.C.
56. Three samples of Indian tussur silk figured-damask, woven in Leek, in 1879.
57. Two specimens of French made open-work dress damasks, Indian tussur silk.

The following articles, included in No. 58 to 62, are manufactured and lent by Messrs. Schottmann & Co., Berlin:—

58. Woollen shawl, with rich effect with tussur silk.
59. Woollen shawl, with open net-work of tussur silk.
60. Machine-knitted salmon-coloured fichu, with alternating wavy lines of tussur silk and wool.
61. Two tussur fichus, in brown and drab, all tussur silk.
62. Tussur silk chenille, in various colours, and cut in a variety of patterns.

The following articles, included in No. 63, are manufactured and lent by Messrs. W. and G. Kessler, Berlin:—

63. A series of tussur chenilles, chenille fringes, trimmings, tassels, toy monkeys and swans, deep fringes of wool and tussur mixed, and pom-poms, manufactured and lent by Messrs. W. and G. Kessler, Berlin.
64. Tussur silk chenille table covers, manufactured by Messrs. Anderson, Lawson & Co.; value, 35s. each.
65. Series of satin damask and brocade of Indian tussur silk, manufactured by Messrs. Devaux and Bachelard, of Lyons; 1 metre each.

66. Six samples of Indian native-woven bleached tussur silk, and three examples of Indian native-woven, unbleached tussur silk for dresses; printed by Thomas Wardle, Leek.
67. Indian tussur silk tram, dyed to the colour of fourteen precious stones, by G. C. Wardle, Leek.
68. Indian tussur raw silk, such as is used for the manufacture of pom-poms, dyed with aniline dyes by G. C. Wardle, Leek.
69. Bundles of three threads organzine of Indian tussur silk, manufactured by Messrs. J. and T. Brocklehurst & Sons, Macclesfield.
70. Lace, manufactured by Messrs. J. Kirkbridge & Co., St. Mary's-gate, Nottingham; the patterned part is made of Indian tussur silk, thrown by Messrs. J. and T. Brocklehurst & Sons, Macclesfield.
71. Three opera shawls, or fichus, unbleached, machine-knitted, manufactured by Mr. Stimson, of Leicester.
72. Cream-coloured bleached opera fichu, of Indian tussur silk, lent by Mr. Maas, of Berlin; also pocket handkerchief and pieces of tussur silk for rain and dust cloaks, lent by Mr. Maas.
73. Pocket-book and garter elastic-webs, in which tussur silk is used, manufactured and lent by Messrs. Archibald Turner & Co., Bow-bridge Mills, Leicester.
74. One 10-yard piece of native woven tussur-silk "chadar" undyed, with red border, for women's wear; woven at Giridi, Bengal.
75. One 10-yard length of native woven tussur silk "dhoti," for men's wear; woven at Giridi, Bengal, undyed, with red border.
76. Indian tussur raw-silk, reeled by Messrs. Louis Payen and Co., at Berhampur.
77. Sample of Indian tussur 2-threads tram, 90 deniers, produced from the above raw silk; thrown in Italy.
78. Scarf of cotton warp and tussur-silk weft; manufactured by Messrs. Kershaw and Swindells, Macclesfield.
79. Three bottles of powdered tussur silk, for surface coating; a new French utilisation.
80. Native spun and woven undyed cloth, made of the silk of the Atlas worm, *Attacus atlas*, Nepal terai.
81. Native spun and woven undyed cloth, made of the silk of the Atlas worm, *Attacus atlas*, Nepal terai; red plaid on undyed ground.
82. Garment of Manipur silk of native manufacture and dye.
83. *La soie Chardonnet*, artificial silk, woven into broad silks and ribbons; the warp real silk, and the weft artificial silk.

84. *La soie Chardonnet*, artificial silk, in skeins, made from cellulose after conversion into gun-cotton and collodion; dyed in black and colours by G. C. Wardle, Leek.

LIST OF SILK-PRODUCING LEPIDOPTERA, BROUGHT UP TO THE PRESENT DATE.

Those marked with an asterisk are in my collection in the imago state. Of those marked with two asterisks I have both imago and cocoon. Of those marked thus (+) I have the larva, cocoon, and imago. Of those marked thus (‡) I have the cocoon only. Those not marked I do not possess in any stage, and I shall be glad to receive larva and moths, but more particularly the cocoons of all or any of these species to assist me in the investigation of the physical properties and structure of the silk fibres of the Heterocera, a work in which I have for some time been engaged.

FAMILY.	GENUS AND SPECIES.	LOCALITY.
Zygaenidae ...	<i>Procris statice</i>	Britain*
"	" <i>geryon</i>	" *
"	" <i>globulæ</i>	" *
"	" <i>chloros</i>	Europe
"	<i>Zygæna minos</i>	Britain*
"	" <i>exulans</i>	" *
"	" <i>tritoli</i>	" *
"	" <i>melloti</i>	" *
"	" <i>loniceræ</i>	" *
"	" <i>filipendulæ</i>	" **
"	" <i>pilosellæ</i>	" *
"	" <i>carniolica</i>	" *
Cochliopodæ	<i>Limacodes testuda</i>	" *
"	" <i>asellus</i>	" *
Nycteolidæ ...	<i>Erias chlorana</i>	" *
"	" <i>vernana</i>	" *
"	<i>Halias prasinana</i>	" **
"	" <i>quercana</i>	" *
Lithosidæ ...	<i>Nola cuculatella</i>	" *
"	" <i>cristulalis</i>	" *
"	" <i>strigula</i>	" *
"	" <i>albulalis</i>	" *
"	" <i>centonalis</i>	" *
"	" <i>togatulalis</i>	" *
"	<i>Nudaria murina</i>	" *
"	<i>Setina irrorella</i>	" *
"	<i>Lithosia mesomella</i>	" *
"	" <i>muscerda</i>	" *
"	" <i>aureola</i>	" *
"	" <i>pygmacola</i>	" *
"	" <i>caniola</i>	" *
"	" <i>helveola</i>	" *
"	" <i>complanula</i>	" *
"	" <i>complana</i>	" *
"	" <i>griseola</i>	" *
"	" <i>stramineola</i>	" *
"	" <i>rubricollis</i>	" *
"	" <i>quadra</i>	" *
FAMILY.	GENUS AND SPECIES.	LOCALITY.
Arctiidae ...	<i>Eulepia grammica</i>	" *
"	" <i>cribrum</i>	" *
"	<i>Callimorpha dominula</i>	" *
"	" <i>hera</i>	" *
"	<i>Euthemonia russula</i>	Jersey*
"	<i>Pleretes matronula</i>	Europe
"	<i>Chelonia plantaginis</i>	Jersey*
"	" <i>caja</i>	" **
"	" <i>villica</i>	" *
"	<i>Ocnogyna pararita</i>	Europe
"	<i>Arctia fuliginosa</i>	Jersey*
"	" <i>mendica</i>	" *
"	" <i>lubricipeda</i>	" *
"	" <i>menthrasti</i>	" *
"	" <i>urticæ</i>	" *
"	" <i>zatima</i>	Europe**
"	" <i>flavia</i>	" *
"	" <i>purpurata</i>	" *
"	" <i>Hebe</i>	" *
"	" <i>aulica</i>	" *
"	" <i>casta</i>	" *
"	<i>Epichnopteryx helcinella</i>	" *
Hepialidæ ...	<i>Hepialus virescens</i>	New Zealand
"	<i>Cossus ligniperd</i>	Europe
"	" <i>terebra</i>	" *
Psychidæ ...	<i>Psyche</i>	Senegal
"	" cocoons found in the Tea-plant.	India
"	" cocoons	Natal
"	" "	" *
"	<i>Psyche graminella</i>	Europe
"	" <i>vilosella</i>	" *
"	" <i>Ecksteini</i>	" *
"	" <i>Zelleri</i>	" *
"	" <i>plumifera</i>	" *
"	" <i>birsustell</i>	" *
"	<i>Thyridopteryx Ephæmeriformes</i>	North America
"	<i>Euneta japonica</i>	India
Liparidæ ...	<i>Liparis chrysorrhæ</i>	Britain*
"	" <i>auriflua</i>	" *
"	" <i>salicis</i>	" *
"	" <i>dispar</i>	" *
"	" <i>monacha</i>	" *
"	<i>Orgyia antiqua</i>	" *
"	" <i>gonostigma</i>	" *
"	" <i>cænosa</i>	" *
"	" <i>leucostigma</i>	Europe+
"	" <i>erice</i>	" *
"	" <i>Josephina Paar.</i>	" *
"	<i>Dasychira confusa</i>	" *
"	" <i>selenitica</i>	" *
"	" <i>pudibunda</i>	Britain*
"	<i>Dicallomera fascelina</i>	" *
"	<i>Calliteara abietis</i>	Europe.*
"	<i>Darala ocellata</i>	Indo - Australasia*

FAMILY.	GENUS AND SPECIES.	LOCALITY.	FAMILY.	GENUS AND SPECIES.	LOCALITY.
Lipariidæ ...	Murlida mutans ...	Indo-Australasia*	Bombycidæ ...	Lasiocampa quercus ...	Britain*
"	" citrina ...	" *	"	" rubi ...	" *
"	" undata ...	" *	"	" lobulina ...	" *
"	Calepteryx collesi ...	" *	"	Hylesia canitiæ ...	Honduras†
"	Laris nigrum ...	Europe.	"	Titya undulosa ...	South America*
Bombycidæ ...	Bombyx Mori ...	Italy. Green cocoons†	"	Macromphalia chilensis.	" *
"	" " ...	" Yellow cocoons**	"	Odonestis potatoria ...	Britain†
"	" " ...	" White cocoons**	"	" albomaculata	Europe*
"	" " ...	Japan white cocoons†	"	" læta ...	" *
"	" " ...	China white cocoons†	"	Crostogastria pruni	" **
"	" " ...	French white and yellow cocoons†	"	" sumatrensis	Indo-Australasia*
"	" " ...	Broussa white and yellow cocoons†	"	Gastropacha quercifolia	Britain†
"	" " ...	Cyprus large white cocoons†	"	" populifolia.	Central Europe†
"	" " ...	Cashmere cocoons†	"	" tremulifolia	Europe*
"	" " ...	Burma **,†	"	" ilicifolia ...	Britain*
"	" " ...	Ceylon **,†	"	" new species	Indo-Australasia*
"	" " ...	Kashmir **,†	"	" suberifolia.	France & Spain*
"	" " ...	Saharanpur **,†	"	" pardale ...	Indo-Australasia*
"	" " ...	Cawnpur **,†	"	Antarctia sordida ...	Europe*
"	" " ...	Lahore **,†	"	Eutricha pini ...	Central Europe**
"	" " ...	Persia **,†	"	Boroceros postica ...	South Africa†
"	" rhadama ...	Madagascar.**	"	Lumacodes bufo ...	Europe & Siberia†
"	" fortunatis ...	Bengal**	"	Cosmotriche lunigera ...	South Germany*
"	" cræsi ...	Bengal**	"	Pachypasa otus ...	Europe & Siberia†
"	" Textor ...	India**	"	Lebeda pithyocampa-	
"	" meridionalis ...	India**	"	crameis ...	Africa*
"	" arracanensis ...	Aracan & Burmah**	"	Gangarides rosea ...	Indo-Australasia*
"	" sinesins ...	India**	"	Megasoma repanda ...	Europe*
"	" processionalis.	Riviera†	"	Drymonia senatoria ...	North America*
"	" borocera ...		"	" alba ...	" *
"	Crateronyx Dumeti ...	Europe.	"	Nemereas trimacula ...	South America*
"	Theophila huttoni ...	India.**	"	Hydrias nacens ...	" *
"	" mandarina ...	China.	"	Gonometa postica ...	Africa*
"	Demas coryli ...	Britain*	"	Palustra burmeisteri ...	South America**
"	Trichiura cratægi ...	" **	Endromidæ ...	Endromis versicolora ...	Britain†
"	Pæcilocampa populi ...	" **	Saturnidæ ...	Attacus atlas ...	India†
"	Malacosoma franconcia	Europe**	"	" cynthia ...	" †
"	Nemeophila alpicola ...	" *	"	" ricini ...	" **
"	Clisiocampa castrensis.	Britain†	"	" insularis ...	" *
"	" neustria ...	" †	"	" hesperus ...	Guiana*
"	" americana	North America*	"	" aurota ...	South America**
"	" innocens ...	" *	"	" jacobæ ...	" *
"	" henckeï ...	Europe*	"	" maurus ...	" *
"	" ursula ...	Africa*	"	" orizaba ...	Mexico *
"	Eriogaster proxima ...	South America*	"	" speculum ...	South America**
"	" hirtina ...	" *	"	" sp. ...	Demerara (G. H. Hawtayne, Esq.)**
"	" lanestris ...	Britain†	"	" arethusa ...	South America*
"	Dasytoma catax ...	Europe†	"	Platysamia cecropia ...	North America**
"	" rimicola-catatax	" †	"	" columbia ...	Columbia*
"	Pachygastria trifolii ...	Britain†	"	" ceonothi ...	North America*
"	" serrula ...	Europe†	"	" calleta ...	South America*
"	Lasiocampa dieckmanni	Siberia*	"	" Gloveri ...	North America
			"	Callosamia angulifera ...	" **
			"	" promethea ...	" **
			"	Telea polyphemus ...	" **
			"	Bunæa alcinoe ...	Africa*

FAMILY.	GENUS AND SPECIES.	LOCALITY.	FAMILY.	GENUS AND SPECIES.	LOCALITY.
Saturniidae ...	Bunœa caffraria ...	South Africa*	Saturniidae ...	Agliatau ...	Central Europe & Northern Asia*
"	Copaxa decesens ...	South America*	"	Polysthana rubrescens...	South America*
"	Syntherata janetta ...	Indo - Australasia**	"	" andromeda..	" "
"	Antheræ assama ...	Assam**	"	Brahmaea lunulata ledereri ...	Europe*
"	" mylitta ...	India*	"	Hemileuca maja ...	North America*
"	" frithii ...	Sikkim*	"	" nevadensis...	" *
"	" helferi ...	" *	"	Rhescyntis crythrina ...	South America*
"	" menippe ...	Africa*	"	" pandora ...	" "
"	" roylei ...	India**	"	Eudelia rufescens ...	" *
"	" pernyi ...	China**	"	Urota sinope ...	Africa*
"	" feltoni ...	" *	"	Micrattacus dissimilis ...	South America*
"	" belina ...	Indo-Australasia*	"	Mimallo despecta ...	" "
"	" yama-mai ...	Japan**	"	Cyrtogone herilla ...	Africa*
"	" eucalypti ...	Indo-Australasia*	"	Molippa sabina ...	South America*
"	" simplex...	Africa*	"	Coloradia venata ...	" "
"	Caligula simla ...	India**	"	Dirphia tarquinia ...	Cayenne**
"	Actias selene ...	" **	"	" vulpina ...	South America*
"	" luna ...	North America**	"	" cinnamomea ...	South America*
"	" artemis ...	Siberia*	"	" marginata ...	" "
"	" isabella ...	Spain†	"	" glauca ...	" "
"	Gyanisia isis ...	Africa *	"	" speciosa ...	" **
"	Saturnia pyri ...	South Europe†	"	Ceratocampa regalis ...	" *
"	" boisduvalli ...	Europe*	"	" imperialis ...	North America*
"	" schenkii ...	" *	"	Rhodia newera ...	India
"	" pyretorum ...	Siberia*	Geometridæ...	Odontopera bidentata ...	Britain**
"	" spini ...	South-East Europe & Western Asia†	"	Ennomos autumnaria ...	" **
"	" grotei ...	Darjeeling	"	Pericallia Syringaniæ ...	Europe
"	" pavonia ...	"	"	Eugoria fuscantaria ...	"
"	" carpini ...	Britain*	"	Epione Apiciaria ...	"
"	" hægi ...	South America**	"	Acidalea luteola ...	Britain†
"	" galbina ...	" *	"	Numeria pulveria ...	" †
"	" janskowskii ...	Europe**	"	Cidaria sagittata ...	" †
"	" diana ...	Europe & Siberia**	"	Seotosia certata ...	" †
"	" mendocina ...	North America*	"	Eupithecia togata ...	" †
"	Atlantica Alg ...	Europe	Drepanulidæ .	Platypteryx lacertula ...	" **
"	Neoris buttoni ...	North-west Himalayas*	"	" sicala... ..	" *
"	Loepa katinka ...	India†	"	" falcula ...	" **
"	Loepa miranda ...	" **	"	" hamula ...	" "
"	Perisomena cæcigena ...	Europe and Western Asia**	"	" unigucula .	" *
"	Hyperchiria io ...	North America**	"	Cilix spinula ...	" "
"	" pamina ...	South America*	"	" glaucata... ..	Europe
"	" metzlii ...	" *	"	Cricula trifenestrata ...	India†
"	" liberia ...	" "	"	Lonomoia albigutta ...	South America*
"	" orodes ...	" *	Pseudo Bombyces, or		
"	" scapularis..	" "	Notodontidæ .	Stauropus fagi ...	Britain*
"	" coresus ...	" *	"	Petasia cassinea ...	" *
"	" viridescens ...	" "	"	" nubeculosa ...	" *
"	" eurypa ...	" "	"	Harpia vinuda ...	" †
"	" illustris ...	" *	"	" bifida ...	" †
"	" complicata ...	" *	"	" furcula ...	" †
"	" salmonia ...	" *	"	Pygoera pigra ...	Europe
"	" beskei ...	" *	"	Clostera curtula ...	Britain*
"	" nyctimena ...	" *	"	" anachoreta ...	" **
"	" aspera ...	" "	"	" reclusa ...	" *
"	" myops ...	" "	"	" anastomosis ...	Europe
			"	Gluphisia crenata... ..	Britain*

FAMILY.	GENUS AND SPECIES.	LOCALITY.	FAMILY.	GENUS AND SPECIES.	LOCALITY.
Notodontidæ.	<i>Ptilophora plumigera</i> ...	Britain*	Noctuidæ ...	<i>Thalpocares Dardonini</i> ...	Europe
"	<i>Ptilodontis palpina</i> ...	"*	"	<i>Erastria Venustula</i> ...	"
"	<i>Notodonta camelina</i> ...	"*	"	<i>Spintherops spectrum</i> ...	"
"	<i>Notodonta cucullina</i> ...	"*	Crambites ...	<i>Galleria cerella</i> ...	Britain**
"	" <i>carmelita</i> ...	"*	"	" <i>mellonella</i> ...	Europe
"	" <i>bicolora</i> ...	"*	Tortrices ...	<i>Tortrix veridana</i> ...	Britain*
"	" <i>dictæa</i> ...	"**	Tineæ ...	<i>Harpipteryx harpella</i> ...	"*
"	" <i>dictæoides</i> ...	"*	"	<i>Hyponomeuta padi</i> ...	"**
"	" <i>dromedarius</i> ...	"*	"	" <i>plumbella</i> ...	"*
"	" <i>tritophus</i> ...	"**	"	" <i>padella</i> ...	"*
"	" <i>ziczac</i> ...	"*	"	" <i>euonymella</i> ...	"*
"	" <i>trepida</i> ...	Britain**	"	<i>Plutella xylostella</i> ...	"*
"	" <i>torva</i> ...	Europe**	Tineidæ... ..	<i>Talæporia politella</i> ...	Europe
"	" <i>chaonia</i> ...	Britain*	"	" <i>pseudo-bom-</i>	
"	" <i>dodonea</i> ...	"**	"	<i>bycella</i> ...	"
"	<i>Diloba cæruleocephala</i> ...	"*	"	<i>Tolenobia clathrella</i> ...	"
"	<i>Heterocampa subrotata</i> ...	North America*	"	<i>Tolenobia pineti</i> ...	"
"	" <i>quadrata</i> ...	South America*	"	" <i>Triquetrella</i> ...	"
"	" <i>amazonica</i> ...	"*	"	<i>Psilothria dardoinella</i> ...	"
"	<i>Edema albifrons</i> ...	North America*	"	<i>Tinea pellielle</i> ...	"
"	<i>Cnethocampa processio-</i>		"	<i>Tinea pseudo bombycella</i> ...	"
	<i>nea</i> ...	South and Central Europe*	Sesiidæ	<i>Trochilium apiforma</i> ...	"
"	" <i>pityocampa</i> ...	North Germany*	"	<i>Heterogynis affinis</i> ...	"
"	" <i>pinivora</i> ...	Europe	"	" <i>Paradona</i> ...	"
"	" <i>Herculeana</i> ...	"*	"	<i>Sarrothripa undulana</i> ...	"
Noctuidæ ...	<i>Diphthea orion</i> ...	Britain	Undescribed cocoons found on the Dow tree } Ranchi, Bengal†		
"	" <i>ludifica</i> ...	Europe			
"	<i>Acronycta aurcoma</i> ...	Britain*	Undescribed cocoons found on the Jamoon tree... .. } Palandu, Ranchi, Bengal†		
"	" <i>menyanthidis</i> ...	"*			
"	<i>Simyra venosa</i> ...	"	Undescribed cocoons } Gambia, West Africa†		
"	<i>Thyatira Batis</i> ...	Europe	Undescribed cocoons found on the Guava tree, <i>A Psychidæ</i> } Dominica†		
"	<i>Arsilonche albovenosa</i> ...	"			
"	<i>Clidia Geographica</i> ...	"			
"	<i>Polia canerces</i> ...	"			
"	<i>Valeria oleagina</i> ...	"			
"	<i>Hadena porphyrea</i> ...	"			
"	" <i>atriplicis</i> ...	"*			
"	<i>Eriopsus Latreilli</i> ...	"			
"	<i>Euplenia lucipara</i> ...	"			
"	<i>Dicycia O O</i> ...	"			
"	" ...	"			
"	<i>Cucullia chamomilles</i> ...	"			
"	" <i>verbase</i> ...	"			
"	<i>Cucullia scrophulariæ</i> ...	Britain*			
"	" <i>tanacetii</i> ...	Europe*			
"	" <i>lactucæ</i> ...	"*			
"	" <i>argentea</i> ...	"			
"	<i>Manestra persicania</i> ...	Persia			
"	<i>Catocala sponsa</i> ...	Britain*			
"	" <i>promissa</i> ...	Europe			
"	<i>Cyonatorpha rideus</i> ...	"			
"	<i>Panthea cænobita</i> ...	"			
"	<i>Eurhipia adaltrix</i> ...	"			
"	<i>Plusia triplasia</i> ...	"			
"	" <i>moneta</i> ...	"			
"	" <i>festuæ</i> ...	"			
"	<i>Aedia funesta</i> ...	"			

DISCUSSION.

Sir GEORGE BIRDWOOD said that Mr. Wardle had attributed too much credit to him, in saying that he was the first to draw attention to the possibility of utilising the tussur silk of India in European manufacture. He had simply not neglected his duty with reference to this interesting silk, whether in connection with the Victoria and Albert Museum, at Bombay, and the India Museum here, or the various international exhibitions held since that of 1851. But, long before his time, the capabilities of tussur silk had been noticed by English naturalists in India; and in certain parts of India—in the Deccan, particularly in the valleys of the Kistná and the Godavary, and throughout the Circars to Orissa, and again on the north-western borders of Hindustan—tussur silk had been woven from time immemorial; and he was of opinion that the earliest silk known to the ancients was tussur, and not mulberry silk. Dr. Roxburgh, a hundred years ago and more, had, in the seventh volume of the Linnean Society's "Transactions," fully described the preparation of tussur silk

in Bengal. But all this had been overlooked and forgotten; and, coming down to our day, it was Mr. Edwin Heycock,* who at the meeting convened by him at Bombay, in 1858, to commemorate the assumption of the direct government of India by the British Crown, by founding the Victoria and Albert Museum, holding up a tussur cocoon before the assemblage, observed that the great use of the museum would be in bringing to light waste Indian products, such as their neglected source of cheap silk. His apt illustration of the potential benefits to be derived from an economic museum at Bombay was received with unbounded enthusiasm, and the incident having been reported all over the world, from that dramatic moment the wild silks of India were never again lost sight of by the manufacturers of the West; with the result, thanks to Mr. Wardle's enthusiastic researches, and Sir Philip Cunliffe-Owen's strenuous advertisement of them at Paris, in 1878, so ably recorded in the paper just read, and further shown in the sumptuous tussur fabrics with which Mr. Wardle has draped these walls. What Mr. Wardle had exactly done in the matter was to make tussur silk merchantable in the same way as mulberry silk, and even to a greater extent; and he had done this by having discovered the means of removing from the fibre of the tussur silk the resinous sheath with which it is naturally invested. Before he had found the means of removing the resinous sheath from it, it would take only certain very dark, not to say lugubrious dyes; but now that, through Mr. Wardle's processes, the resinous sheath can be removed, tussur silk will take nearly every dye that mulberry silk takes, and can be used by manufacturers as widely as the latter, if not more so; for while tussur silk, without its resinous sheath, takes all our lighter dyes, with its resinous sheath on, it still, of course, takes all the darker dyes with which it has so long been associated. There is, therefore, a great and a growing future before it; and it is indeed impossible to exaggerate the importance of the services rendered by Mr. Wardle to every tussur-producing country of the East. He is certain to be recorded in history as one of their best benefactors, and Sir Philip Cunliffe-Owen's name will always be associated with his in this con-

nection. Unfortunately nearly all the benefit of Mr. Wardle's researches had been taken advantage of by the Chinese, and not by the people of India, for whom they were expressly undertaken. What the explanation might be he could not say, but a part of it must, he feared, be attributed to the want of commercial enterprise in the people themselves. But still they must benefit by Mr. Wardle's life work in the end. He was sorry to say anything that might seem harsh of Mr. Wardle on an occasion of so much justifiable congratulation. But in one part of his paper Mr. Wardle had slipped into the error of speaking of the "regular results" he "hoped" would be obtained by improved processes of reeling tussur silk in India. Why one of the accidental artistic qualities which made Indian textile fabrics so "precious" in the eyes of persons of "taste" was dependent on the "irregular results" of the primitive, traditionary methods still followed by the people of India in spinning silk, wool, and cotton. These irregular results gave a surface play of light and shade, the absence of which was one of the most marked defects of mechanical spinning and weaving. It was an extraordinary illustration therefore of inborn perversity that a man of Mr. Wardle's genuine artistic sensibility should praise the anticipated "regular results" of the Italian methods of spinning that are being introduced into India. But he did not mean what he said, and had but slipped with his tongue. It reminded him of a resolution moved at the Indian Congress of 1887 by a Hindu gentlemen, condemning the people of India for going on spinning and weaving in exactly the same fashion as their forefathers 3,000 years ago, as if it was possible to improve on perfection! Again, Mr. Wardle spoke of "ameliorating the natural colour of tussur silk," by scorching it to a leprous white with oxygen. And, worst of all, he spoke of the production of artificial silk fibre from celluloid as "progress." The next step in this sort of "progress" would be the production of celluloid silk in sheets, like "mackintosh." That sort of "progress" was simply damnable. He must, however, unreservedly congratulate Mr. Wardle on his paper, and thank him for the fulness with which he had illustrated it, by the splendid tussur stuffs hung round the room. He must also express his personal thanks to her Ladyship for presiding. It was the first time a lady had presided at a meeting of the Society of Arts, and he sincerely trusted it would not be the last. In conclusion, Sir George Birdwood read a letter from Mr. Lazenby Liberty, expressing his regret at not being able to be present at the meeting and testify personally to his sense of the vast importance of Mr. Wardle's labours in developing the utilisation of tussur silk, and, acknowledging also the great impulse he had given during the last few years to the reviving of silk manufactures of the United Kingdom.

* This gentleman was Sheriff of Bombay for 1858; and he was also the author of a thick duodecimo volume, which went through two or three editions, on "The Exodus of the Israelites out of Egypt," the object of which was to prove from Jewish prophecy that Egypt was predestinated for the English. He was almost singular among the merchants of his day, in Western India, in knowing anything of the country and its people beyond the limits of the town and island of Bombay. Yet a more eminent exception to their ruling ignorance in this respect was Mr. Walter R. Cassels, the author of an invaluable report on "Cotton and its Culture in the Bombay Presidency" [Bombay, 1862]; and of a most dainty duodecimo volume of transcendental poetry, entitled, "Eidolon, or the Course of the Soul," published by Pickering, 1850. Mr. Walter Cassels was the brother of Mr. Andrew Cassels, for so many years a Member of the Council of the Society of Arts, and also of the Secretary of State for India.

Mr. LEWIS DAY said that he had no claim to speak

on the subject, which was more scientific than artistic; but so far as art was concerned, Mr. Wardle had abundantly proved that tussur silk lent itself to beautiful effects of colour, and all artists must be thankful to him for having brought about its introduction. He agreed with Sir George Birdwood as to the beauty of Oriental dyeing; it was a mistake to try to equalise everything, as British merchants endeavoured always to do. What difference there was between tussur silk and mulberry silk, so far as colour was concerned, seemed rather to the advantage of tussur silk. There was a certain tone in the silk itself which helped to qualify the raw colours too frequently used.

Mr. MARTIN WOOD considered that Mr. Wardle had done immense service to India and England, by neutralising its adverse conditions and thus utilising tussur silk, although the Chinese had sent it to this country long before. The examples which had been given of perseverance, and overcoming the essential difficulties of dyeing the fibre, were worthy of all praise. Whilst he had done so much, he (Mr. Wood) should like to point out another direction in which similar efforts might be taken with great advantage; and that was with regard to the tussur being improved by crossing it with the Japan moth which was similar to the moth described by Mr. Wardle as feeding upon the oak. The hybrid worm produced a very fine silk, it being free from the resinous substance which had prevented tussur silk from being dyed. Mr. Wardle did not wish to displace from its queenly position the *Bombyx mori*, but its sway was restrained by the fact that the mulberry tree could not be grown in all parts of India. One advantage of tussur silk was that it was wild and cost nothing to produce; but shortly there would be great difficulty in obtaining it, so the supply would become limited. When that happened, the cost would consequently be increased, and hence arose the necessity for cultivating it. If that had to be done, it would be worth considering whether it would not be better to cultivate the superior moth to which he had just referred. So long ago as 1882, and again in 1887, he pointed out, in the *Journal*, that this superior moth could be cultivated in every part of India, and it would fill the place between the tussur moth and the *Bombyx mori*; for trees suitable for the hybrid moth grow in all parts of India.

SIR PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., said that he wished more interest were taken in India itself in Mr. Wardle's life-long labours to develop the use of the wild silks of that country. He at first became interested in the subject in the early part of 1874, when he received quite a mysterious visit from Mr. Wardle, who came to him for assistance in the investigations he then commenced on behalf of the India-office regarding the utilisation of tussur silk. Since then, he had closely followed every step in the

remarkable developments of Mr. Wardle's labours with ever growing satisfaction; it was, indeed, a cause of pride to him to-day, as he was sure it must also be to Mr. Wardle, to see hung all round this room such a magnificent display of the results of his researches—so fruitful of good to India and China, and carried out in such a wholly disinterested, and, indeed, self-denying spirit by himself. He was especially proud of the part he had taken in the Paris Exhibition of 1878, in drawing attention to Mr. Wardle's exhibits on that occasion, when not only was a Grand Gold Medal of Honour given for Indian teas, but a second Grand Gold Medal of Honour for Indian silks. A number of lesser medals were also secured for the Indian teas; and it was these awards which advertised Indian teas and tussur silk all over the world, and the wonderful increase in the use of Indian teas in every part of Europe, and of tussur silk in France since 1878, was entirely due to these signal awards. The world owed a deep debt of gratitude to Mr. Wardle for his persevering efforts; and he hoped the India-office would translate his paper into French, German, and Hindustani, and scatter it broadcast through Europe and the United States and India. They would, indirectly, reap a rich reward for it.

Lady EGERTON said she had learned a great deal from the interesting paper read by Mr. Wardle, and the way in which it had been illustrated by the different specimens shown must appeal to every feeling. From the cursory inspection which she had made of the silks, they appeared to be very thin. Her own experience of tussur silk was that when made into a dress it fell in irregular folds, and she should like to know from Mr. Wardle whether it could not be manufactured so as, when made up, to fall in artistic folds, the same as mulberry silk.

The vote of thanks to the author having been carried,

Mr. WARDLE, in reply, said some of the fabrics were very thin, and some very thick; but there were a great number of varieties between the two. A fabric, such as that required for the best purposes of dress, would never equal those of the best silk; but there were a great many purposes for which it could be used, chiefly for furniture silks, and for cloaks and shawls, and even for dress secondary only to best silk; but one of its chief uses was for trimmings and chenille, in which very successful effects were produced, both on the Continent and in England, as these beautiful and artistic samples proved. The silk was naturally harder than the silk of commerce, and always would be. It would scarcely fall in such graceful folds as mulberry silk, but it perhaps might, if judiciously mixed with other silks. The way tussur silk was woven in the crude looms in Bengal was such as to make it harsh; but some of the Lyons specimens which he had brought would fall into excellent

folds, as also two specimens of figured damasks, which he omitted to notice, but which he now handed to Lady Egerton; and he was glad to be able to state they were manufactured in London. They were very beautifully made, and seemed to meet every requirement. There were also three shawls on the wall that were made in Leicester, and one made in Berlin, the cream colour in the latter being produced by means of the action of nascent oxide on the fibre. It was most gratifying to him to hear his labours so well spoken of both by Sir George Birdwood and Sir Philip Cunliffe-Owen. Such generous recognition of work was in itself no slight reward; but it was necessary for him, in order to correct any misapprehension which might arise as to the nature of Sir George Birdwood's remarks about manufacturing and dyeing operations, to say that if Sir George had been a manufacturer he would have looked at the question of what he calls "regular results" from an industrial point of view. In his present remarks he simply looked at it in an æsthetic sense. With all respect for the artistic side of the question, he must enter his protest against any defence or encouragement of imperfect and slovenly work. The native reeling of tussur cocoons in India was very imperfect; of that there could be no manner of doubt. It surely could not be artistic or æsthetic to pull off a thread from the cocoon, which the worm had deposited in perfect order, in a disorderly rabble, and he would refer Sir George to the remarks in his paper which, for want of time he had been obliged to omit reading, where he referred to cocoon reeling, and to what the French termed *duvet*. Could it be defended that if a ball of worsted had to be unwound into a skein, that the skein should become a series of tangled rabbles. That was exactly the case in most of the native Indian and China reeling of tussur cocoons. With regard to the bleaching of tussur silk, the same line of defence must be taken up. It was all very well to defend natural results, but everything that had been done in the direction of improving the dyeing of this silk had been done in an artistic direction, inasmuch as both the natural colours of the raw tussur silk of India and China was simply that of a dirty drab, in which state it was not possible even to dye into the warm artistic tones of colour. The Indian people themselves had tried, but for centuries with the worst results. Now that the so-called resinous brown colouring-matter can be discharged, tussur silk can be dyed into those most delicate and beautiful shades of colour which Indian people themselves love so much to wear; and it never could have been accomplished without the removal of what is simply a dirtystain. And Mr. Day was in error in thinking that the drab tone of tussur silk aided the effect of applied colour: the very reverse of this was the case. In the Zoological Gardens at the present time there were tussur moths and worms in the living state, and Mr. Sclater had sent word to say that these specimens might be seen. He was very much obliged to Sir Philip Cunliffe-Owen for the interest which he had

always displayed in this matter. In 1879 the shipment of Chinese tussur silk to Europe was 169,466 lbs., but in 1887 it had grown to the enormous figure of 3,375,500 lbs. Notwithstanding the great consumption of China tussur he might say that for the whole of 1878 there were only 150 bales of tussur silk conditioned in Lyons, and the whole of this was not used, but for the week ending in April, 1891, there were 136 bales of tussur silk conditioned, as against 178 French and 38 Italian.

The vote of thanks to Lady Egerton for presiding having been unanimously passed, the proceedings terminated.

Miscellaneous.

BEER PRODUCTION AND CONSUMPTION IN THE ARGENTINE REPUBLIC.

The United States Consul at Buenos Ayres says that the Argentines were not originally drinkers of beer, but have acquired the habit rather through their associations with the people of the Old World. Until within comparatively recent years, they have been noted for their preference for wine, and beyond what the country produced, the quantities especially of the light table wines annually imported from France, Spain, and Italy, have been, it is stated, one of the marvels of the Buenos Ayres Custom-house. Within the advent, however, of European, and especially German immigrants, a change in the drinking habits of the people has been gradually effected, and Argentines, at the present day, consume considerable quantities of malt liquor. As regards the production of beers in any systematic or scientific way, until recently they possessed neither the requisite knowledge nor the necessary materials. Now, however, large breweries and the most approved appliances are to be found in different parts of the country. It must not be understood that no fermented liquors were made in the country, nor that the natives confined their potations exclusively to wines. Beer-drinking and beer-making, such, indeed, as it was, in the Argentine Republic, has a history which dates back before the Spanish conquest. From time immemorial, long before the landing of the Spaniards in South America, the native Indians fermented and brewed a beer from maize, or Indian corn, which, in some parts of the country, was called *chicha*, and, in others, *aloga*. In the western provinces of Bolivia, and in the provinces of Satta, Jujuy, and Santiago del Estero, this beer is still manufactured, and has a great reputation with the natives and half-breeds, however repugnant may be its method of preparation. The maize, after being coarsely masticated or chewed,

is spit out into a large kettle or boiler, which is filled with water and placed on a fire. A thick scum rises to the top, then, after several hours of boiling, it is taken off and left to ferment. In about forty-eight hours the liquor is decanted and placed in a jar, where it continues to ferment lightly. In this state it is somewhat thick and cloudy, and a kind of yellow oil floats on the surface, but at the end of another two days the *chicha* is ready for use. Its taste is said to slightly resemble that of a sweet wine, and on the whole not to be disagreeable. It will intoxicate if too freely taken. Another method consists, where they have the facilities, of breaking the corn in a mortar, and then placing it in a kettle, completing the operation as in the former case. While this method is decidedly more cleanly, the product is much more unpleasant to the taste, and the other is greatly preferred. In the province of Tucuman, they put the maize at the bottom of a jar, pour boiling water over it, and then leave it to ferment. It is called *aloga*, and is said to be very refreshing. In the provinces of Rioja, Santiago del Estero, Cordoba, and Tucuman, beer is made from the fruits of the *Algorroba*, the *Molle*, and the *Chanar* trees. It is prepared by infusing the fruits, sometimes in cold, but more frequently in boiling water, and waiting until the alcoholic principle begins to develop itself. The beer thus made is of moderate strength, but its taste, though very satisfactory to those who live in the far interior, is sufficiently repugnant to a traveller. All these *chichas* are very much used by the natives of the country during the fruit season, constituting in those remote regions, in many cases, the principal beverage on festive occasions. In regard to the ordinary malt beers of commerce, it is now some years since establishments for this production first began to be operated in Buenos Ayres. They are now also to be found in Montevideo, Rosario, Cordoba, Gualaguichu, and other centres of population in the Argentine Republic. In former years these breweries had to depend almost entirely upon foreign countries for the barley they required; but with the progress of agriculture, no inconsiderable amount of that grain is now raised in the country itself. It is evident, however, that not enough is yet produced to meet the demand, as the Custom-house returns still show large importations both of barley and malt. As regards the latter, except a very small proportion, which is credited to Belgium, France, and Great Britain, all the malt brought to the Argentine Republic comes from Germany or Austria. While barley has now become one of the regular crops of the country, and the area under this cereal is every year becoming larger, nothing as yet has been done towards the cultivation of hops. In the valleys of the province of Rioja, where the temperature is almost sub-tropical, there is found a native variety of hops which has lately attracted some attention, and it is thought that good hops could be cultivated in that part of the country. At present, however, all the hops used in the production

of beer are imported from Europe, and the demand is every year increasing. Notwithstanding these drawbacks, however, brewing on scientific principles is making very considerable progress in the Argentine Republic. At the present time there are, in the City of Buenos Ayres, no less than eight well-appointed brewing establishments, with a total capacity of about 128,000 litres daily. In the city of Rosario there are four breweries, with a capacity of about 25,000 litres daily; and in all the other more important towns of the Republic, one or more breweries are now to be found, most of them with small plant, though that on the Rio Segundo, near the city of Cordoba, called the Anglo-Argentine Brewery, is famous not only for its perfect appliances, but for the excellence of its product. In Buenos Ayres, the breweries are all in the hands of persons who have learned their business in Europe, and in respect of their beers, Consul Baker says that while all will favourably compare with the ordinary lager beer of the United States, some brands are noted for their excellence. Among these breweries there is one establishment which for its size, for the extent and solidity of its cellars and buildings, for the amount and completeness of its machinery, and for the quantity and quality of its products, compares, says Consul Baker, very favourably with the largest and best appointed breweries of the United States. In order to better protect the brewing industry of the country, the Argentine Customs tariff on imported beers has of late years been considerably increased, and this, it is said, has had the effect of greatly stimulating the production and consumption of native fermented liquors. Notwithstanding the increased duty, however, and the very considerable quantities of beer produced in the country, there is still a large and continuing demand for foreign beers and ales. The greater part of the imports come from the United Kingdom and Germany. From the former come pale ales, porter, and stout, while Germany sends "Imperial," "Mainz," "Culmbacher," "Pilsener," &c.

AGRICULTURAL COLONIES IN VENEZUELA.

The Belgian Chargé d'Affairs at Caracas, in a recent report to his Government upon the condition of agricultural emigrants to Venezuela, says that the authorities there make a grant to agricultural colonists of one hectare (2.47 acres) of cultivatable land to each adult. It is first leased to them on a provisional title, which after a certain time and the cultivation of the land, is exchanged for a permanent one. The Government guarantee to the immigrants the free exercise of their religion, and all the liberties which the State guarantees to native citizens. Immigrants coming to Venezuela, by profiting from the advantages and immunities granted to them, become Venezuelan citizens without the formality of naturali-

sation. It is not lawful for them to renounce their Venezuelan nationality. They are free for the first ten years of their residence from any military service, except in the case of war with a foreign power. They cannot quit Venezuelan territory within two years, and they lose all right to protection from the representatives of their native country. There are certain agricultural colonies established and regulated by the State, the principal of these being in Bolivar and Independencia. These colonies, established in 1874, are both situated in the warmer part of the country, and are, consequently, says the Charge d'Affaires, ill suited to Belgian and English agriculturists. The Independencia colony is chiefly peopled by Venezuelans, then Spaniards, Italians, and a few French. According to the census of 1881, this colony comprised 352 houses and 1,496 residents. The population of the Bolivar colony consisted, in 1888, of 127 families, comprising in all 845 persons. The fact that the colonists consist of Southerners, Venezuelans, Spaniards, Canary Islanders, &c., is not, any more than the climate, of a nature to attract Englishmen and Belgians. "I am certain," says the Chargé d'Affaires, "That the latter would feel very unhappy in the midst of a population whose character, customs, and mode of living differ so essentially from their own." Besides these two Government colonies there also exists an agricultural colony, the establishment of which is due to private initiative. An old Venezuelan family has left lands extending many leagues for the establishment of an agricultural colony. This colony is known as the Tovar Colony, or German Colony, because it is exclusively composed of colonists of that nationality. This colony is situated in the neighbourhood of Victoria, about two days journey from Caracas, in the mountains, at an altitude of from 1,900 to 1,950 metres above the level of the sea. The climate is temperate and favourable to Europeans. The colonist, on starting a working or the building of a house, receives gratis a plot of cultivable land, of which he becomes the sole owner, with the restriction that he can only re-sell it to another member of the colony. The colonists say that the plot of land which is conceded to them is not sufficient to meet the requirements of a household. It is stated, however, that some of the colonists, a small minority, have been able to save something; they have purchased or leased, outside the colony, certain plots of land, which they cultivate themselves or lease to others. In the immediate environs of the colony there no longer exist unclaimed lands, *tierras baldías*. All is owned by private individuals, and the opportunity of acquiring a portion of land there is excessively small. The Venezuelan holds fast to his little property, and always gives it an absolutely exaggerated value. The colonists live, as a rule, very poorly; they cultivate coffee, maize, beans, and a few fruits. In time, wheat and potatoes, it is stated, will also be cultivated, but these crops have been discouraged. The colonists possess a few

cattle and some poultry; they make butter which is sold once a week at Caracas, where it is in great demand. Coffee, maize, and beans are sold to travelling merchants. The lack of roads, and the defective condition of the railways, keep the colonists almost aloof from the surrounding world. The colonists have suffered much from civil wars; in times of trouble they are regularly besieged by the insurgents, and by the troops of the party in power. More than once their cattle and crops have been thus destroyed. Within recent years a certain number of colonists, in despair of improving their position, or even of making enough to live on decently, have quitted the colony and established themselves in Caracas or its environs as artisans or workmen. The Belgian Chargé d'Affaires discourages his countrymen from coming to settle in Venezuela as agriculturists, and says that the results obtained, after fifty years of hard work by an honest and industrious population, whose manners and character compare favourably with those of Europeans, are not of a nature to tempt Belgians to try their hand. It may be true, that in Venezuela there are vast areas of fertile land, which only require the raking of the soil to render them fit for production, but this is not all that is required. What is, above all, necessary is, that the products should be able to find a ready market; and this is a condition which is absolutely unfulfilled in the greater part of Venezuela. What is urgently needed is an improvement in the ways of communication; without this, it is impossible, says the Belgian Chargé d'Affaires, for the agricultural colonist to succeed.

WINE INDUSTRY OF CALIFORNIA.*

A report, in connection with the United States Census upon the viticultural industry in that country has recently been issued by Mr. H. Gardner, Special Census Agent. It is stated in the report that in California there are fifty-three counties nearly all producing grapes, the larger proportion of them producing wine for home consumption or export. There is an established demand for this wine to the extent of 1,000,000 gallons a month. California may be divided into three grape-growing districts—the coast, which includes Sonoma, Lake, Napa, Alameda, Santa Clara, and Santa Cruz counties; the Sierra Nevada, Foothill, and Sacramento Valley district, which includes Placer, El Dorado, Calaveras, Tuolumne, Yuba, Yolo, Butte, Sacramento, and Tehama counties; and the southern district, which includes San Joaquin, Merced, Fresno, Tulare, Kern, Ventura, Santa Barbara, San Bernardino, Los Angeles, and San Diego. In the first district the finer grades of white and red dry wines are produced. The choice varieties of the French and German types appear, it is said, to come nearer reproducing themselves here than elsewhere. In this district are successfully grown the finest varieties of French champagne grapes, which yield a handsome profit to the pro-

ducers. There is one cellar in this district with a capacity of 800,000 bottles, producing champagne by natural fermentation in the bottle. The champagne industry in California is a growing one, and its future is said to be a very bright one. Some good, wholesome dry wines are produced in the second district, but they are of a different character from the German and French types. In the Sacramento and San Joaquin Valleys, and in the southern district, some excellent dry wines are produced, but these valleys excel in their Port, Muscatel, Angelica, and other full-bodied sweet wines. Tehema, which is in the second of the above-mentioned districts, has the largest vineyard in the world, 3,800 acres in extent, to which the manager states that 1,000 acres of new vines are to be added within a year. There were in the distillery belonging to this vineyard, in April, 1890, when visited by the special agent of the Census Office, 300,000 gallons of brandy and 1,000,000 gallons of wine. Another large vineyard, the second largest in the State, contains 1,500 acres, and is situated at Folsom, Sacramento county. The cellars attached to this vineyard are capable of holding 600,000 gallons. Near Stockton, in San Joaquin county, which belongs to the third of the districts enumerated above, is located one of the most important vineyards. Fine brandies are made in this district, also sherries, ports, and some excellent clarets. In Fresno county there are at the present time 25,000 acres of bearing vines and 15,000 acres of new plantings, the largest portion of which is grown for raisins. There is, however, a considerable quantity of wine and brandy made in this county. The wines are mostly sweet, and of excellent quality. More than half the raisin grapes grown in California are produced in Fresno county. San Bernardino is also principally devoted to the growing of raisin grapes. There are 9,562 acres of bearing, and 4,125 acres of non-bearing vines, and the raisin crop for 1889 amounted to 375,000 boxes. Two vineyards in San Bernardino produced 279,000 gallons of wine in 1889. There were also produced from this district 1,700 tons of table grapes. Los Angeles county has 18,120 acres of bearing vines. In this county there were produced in 1889 25,820 tons of grapes for wine making. The wines in this county are justly celebrated, and were the first shipped from California to the eastern markets. This county excels in its sherries, ports, and brandies. In San Diego county there is an acreage of 6,000 bearing and 7,500 non-bearing vines. It is in the El Cajon Valley of San Diego county that the greatest progress has been made in viticulture, and the grapes from this valley are among the finest produced in California. As it has been stated that California has the largest vineyard, it may be interesting to note that she has also the smallest. This consists of a single vine, in Santa Barbara county. It was planted by a Mexican woman, 68 years ago, and has a diameter, one foot from the ground, of 12 inches, its branches covering an area of 12,000 feet, and produces annually from 1,000

to 12,000 pounds of grapes. The total wine production of California in 1889 amounted to 14,626,000 gallons, of which 3,000,000 were produced in the county of Napa, 2,260,000 in Santa Clara, 1,756,000 in Sonoma, 1,342,800 in Los Angeles, 1,200,000 in Fresno, and 1,000,000 gallons in Alameda county. The total Californian product for 1890 is estimated at 16,500,000 gallons.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 15 ... Geographical, University of London, Burlington-gardens, W., 2½ p.m. Annual General Meeting

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m.

TUESDAY, JUNE 16...Statistical, School of Mines, Jermyn-street, S.W., 7½ p.m. Mr. Noel A. Humphreys, "Results of the recent Census, and recent Death-rates in the largest English Towns."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. A. Boulenger, "A Contribution to the Knowledge of the Races of *Rana esculenta* and their Geographical Distribution." 2. Mr. Oldfield Thomas, "Notes on Ungulates." 3. Mr. Edgar A. Smith, "A Collection of Marine Shells from Aden, with some remarks upon the Relationship of the Molluscan Fauna of the Red Sea and the Mediterranean."

WEDNESDAY, JUNE 17 ... SOCIETY OF ARTS, 9 p.m. Conversazione at the South Kensington Museum.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Alfred Hands, "A Curious Case of Damage by Lightning." 2. Mr. William Ellis, "Mean Temperature of the Air at the Royal Observatory, Greenwich, as Deduced from the Photographic Records 1849-1888." 3. Mr. William Ellis, "Comparison of Thermometrical Observations in a Stevenson Screen, and on the Revolving Stand at the Royal Observatory." 4. Mr. W. F. Stanley, "Phonometer." 5. Mr. Alex. B. Mac Dowall, "Some Suggestions bearing on Weather Prediction."

Microscopical, 20, Hanover-square, W., 8 p.m.

Royal Institution, Albemarle-street, W., 4 p.m. Faraday Commemoration Lecture, by Lord Rayleigh.

Obstetrical, 20, Hanover-square, W., 8 p.m.

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Summer Exhibition.

THURSDAY, JUNE 11...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Mr. Spencer Moore, (1) "An Investigation into the true nature of Callus" (Part II.); (2) "The Alleged Existence of Protein in the Walls of Vegetable Cells, and the Microscopical Detection of Glucosides therein." (Part I.)

Chemical, Burlington-house, W., 8 p.m. 1. Mr. N. Collie, "The Action of Sulphuric Acid on Dehydracetic Acid." 2. Dr. W. H. Perkin, "The Refractive Power of certain Organic Compounds at Different Temperatures."

Historical, 20, Hanover square, W., 8½ p.m. Mr. Herbert Haines, "France and Cromwell."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, JUNE 19...United Service Inst., Whitehall-yard, 3 p.m. Rear-Admiral P. H. Colomb, "The Principles of Retirement in the Services."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Journal of the Society of Arts.

No. 2,013. VOL. XXXIX.

FRIDAY, JUNE 19, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE
FOR THE YEAR ENDING MAY 31ST, 1891.

Dr.		£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1890.....		1,144	14	7			
Do. in hands of Secretary...		11	19	1			
„ Subscriptions received during the year from Members and Institutions in Union	5,782	16	0		1,156	13	8
„ Life Compositions.....	567	0	0				
					6,340	16	0
„ Dividends and Interest					692	4	9
„ Ground Rents					309	9	6
„ Examination Fees					433	10	0
„ Prize Fund Donations:—							
Goldsmiths' Company.....	25	0	0				
Mercers' Company	21	0	0				
Clothworkers' Company.....	20	0	0				
Skinners' Company	5	5	0				
Salters' Company	5	5	0				
					76	10	0
„ Advertisements.....					766	16	2
„ Sales, &c.:—							
Cantor Lectures.....	30	4	0				
Conversazione Cards	202	4	0				
Examination Papers.....	0	3	3				
Fees for use of meeting-room	35	14	0				
<i>Journal</i>	169	8	9				
Spoiled Post-cards	2	11	6				
					440	5	6

Cr.		£	s.	d.	£	s.	d.
By House :—							
Rent, Rates, and Taxes	341	13	8				
Insurance, Gas, Coal, House expenses, and charges inci- dental to meetings	307	17	5				
Repairs and Alterations	142	1	11				
					831	13	0
„ Office :—							
Salaries and Wages	2,194	13	6				
Stationery, Office Printing, and Lithography.....	264	9	3				
Advertising	86	12	2				
Postage Stamps, Messengers' Fares, and Parcels.....	204	7	5		2,750	2	4
„ Library, Bookbinding, &c.....					70	3	8
„ Conversazione (1890)					670	18	9
„ Journal, including Printing, Stamps, and Distribution.....					2,198	4	1
„ Advertisements (Agents and Printing)					404	14	1
„ Examinations					528	2	7
„ Medals :—							
Albert (printing).....	1	3	9				
Society's	25	16	0		26	19	9
„ Drawing Society Prizes.....					6	9	0
„ Owen Jones Prizes.....					19	11	0
„ Cantor Lectures.....					283	7	6
„ Popular Lectures.....					52	10	0
„ Juvenile Lectures					23	0	0
„ Memorial Tablets.....					5	2	6
„ Sections :—							
Applied Art	61	12	0				
Foreign and Colonial	61	12	0				
Indian.....	65	2	0		188	6	0
„ Committees (General Expenses).....					11	19	11
„ Investments :—							
Consols (Life Compositions of the year)	567	0	0				
Do. (from Society's Income)	500	0	0				
Accumulation of Interest on Trusts placed on Deposit...	50	0	0				
Do. added to “Aldred” Trust	31	18	4		1,148	18	4
					9,220	2	6
„ Cash in hands of Messrs. Coutts and Co., May 31st, 1891	986	18	2				
Do. in hands of Secretary	18	4	11		1,005	3	1
					£10,225	5	7

LIABILITIES.			ASSETS.		
	£	s. d.		£	s. d.
To Accounts due	420	18 9	By Society's Funds invested in—		
„ Examiners' Fees	225	3 0	£9,237 12s. 8d. Consols, esti-		
„ Examination Prizes	62	0 0	mated at	8,931	4 2
„ Do. Balance of Grants by City			£500 Canada 4 per Cent. Stock,		
Companies	36	10 0	estimated at	515	0 0
„ Sections :—Applied Art, Foreign			£500 South Australia 4 per Cent.		
and Colonial, and Indian	160	0 0	Stock, estimated at	520	0 0
„ Accumulation under Trusts	403	11 7	£530 10s. 1d. New South Wales		
			3½ per Cent. Stock, estimated		
			at	525	3 0
			£217 Great Indian Peninsula		
			Railway 4 per Cent. Debenture		
			Stock, estimated at	269	1 7
			£1,500 Queensland 4 per Cent.		
			Bonds estimated at	1,530	0 0
			£500 Natal 4 per Cent. Stock,		
			estimated at	525	0 0
			Ground Rents	526	18 9
				13,342	7 0
Excess of Assets over Liabilities			„ Subscriptions of the year un-		
			collected	590	2 0
			„ Arrears, estimated as recoverable	200	0 0
			„ Property of the Society, including Barry's		
			Pictures and Lease of House	2,000	0 0
			„ Advertisements on the Books, due and in		
			course of execution*	765	7 3
			„ Cash in hands of Messrs. Coutts and Co.,		
			31st May, 1891	986	18 2
			„ Do. on Deposit (interest on Trusts)	400	0 0
			„ Do. in hands of Secretary	18	4 11
				18,302	19 10
				18,302	19 10

* A portion of this sum is subject to charges for printing.

INVESTMENTS, &c., STANDING IN THE NAME OF THE SOCIETY.

Ground Rents	£7,690	0	0
Consols	10,841	12	11
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500	0	0
Bombay and Baroda Railway 5 per Cent. Guaranteed Stock	2,450	0	0
Canada 4 per Cent. Stock	923	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales $\frac{3}{4}$ per Cent. Stock	530	10	1
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Bonds	1,500	0	0
Natal 4 per Cent. Stock	500	0	0
Cash on Deposit with Messrs. Coutts and Co.	400	0	0

TRUST FUNDS INCLUDED IN THE ABOVE.

1. Dr. Swiney's Bequest.....	£4,500	0	0	Invested in ground-rents, and chargeable with a sum of £200 once in five years.
2. John Stock Trust.....	100	0	0	Consols, chargeable with the Award of a Medal.
3. Benjamin Shaw Trust for Industrial Hygiene Prize.....	193	6	8	" " " Interest as a Money Prize.
4. North London Exhibition Trust.....	132	2	2	" " " "
5. Fothergill Trust.....	388	1	4	chargeable with the "Award of a Medal."
6. J. Murray, in aid of a Building Fund.....	54	18	0	" " " "
7. Subscription to an Endowment Fund.....	562	2	2	" " " "
8. Dr. Aldred's Bequest.....	173	10	0	" " chargeable with the Award of a Prize.
9. Thomas Howard's Bequest.....	500	0	0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock, chargeable with the Award of a Prize for an Essay.
10. Dr. Cantor's Bequest	4,600	0	0	Bombay and Baroda Railway Stock, and Ground-rents, Interest applied to the Cantor Lectures.
11. Owen Jones's Memorial Trust.....	423	0	0	Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12. Mulready Trust.....	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13. Alfred Davis's Bequest.....	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
14. Accumulated Interest on Trust Funds	400	0	0	On Deposit with Messrs. Coutts and Co.

The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

OWEN ROBERTS,
FREDERICK BRAMWELL. } *Treasurers.*

OWEN ROBERTS, } *Treasurers.*
FREDERICK BRAMWELL, }
J. O. CHADWICK & SON, *Auditors.*

HENRY TRUEMAN WOOD, *Secretary.*

Society's House, Adelphi, 16th June, 1891.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-Seventh Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 24th June, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD,
Secretary.

ALBERT MEDAL.

The Council of the Society of Arts have, with the approval and sanction of the President, H.R.H. the Prince of Wales, awarded the Albert Medal to Sir Frederick Abel, K.C.B., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

MEDALS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1890-91:—

To J. F. GREEN, for his paper on "Steam Life-boats."

To A. G. GREEN, C. F. CROSS, and E. J. BEVAN, for their paper on "Photography in Aniline Colours."

To CARMICHAEL THOMAS, for his paper on "Illustrated Journalism."

To Colonel Sir CHARLES WILSON, K.C.B., K.C.M.G., F.R.S., for his paper on "Methods and Processes of the Ordnance Survey."

To A. P. LAURIE, for his paper on "The Durability of Pictures painted with Oils and Varnishes."

To Prof. WILLIAM ROBINSON, for his paper on "The Use of Petroleum in Prime Motors."

To Prof. J. J. HUMMEL, for his paper on "Fast and Fugitive Dyes."

To Sir EDWARD N. C. BRADDON, K.C.M.G., for his paper on "Recent Development of Tasmanian Industries."

To Sir THOMAS WADE, G.C.M.G., K.C.B., for his paper on "China."

To B. H. BADEN-POWELL, C.I.E., for his paper on "The Indian Village Communities, with Special Reference to Modern Investigation."

To THOMAS WARDLE, for his paper on "The Use of Tussur in European Textile Manufactures."

To CHARLES L. TUPPER, B.A., for his paper on "The Study of Indian History."

To WILLIAM SIMPSON, for his paper on "Lithography: a Finished Chapter of Illustrative Art."

To G. T. ROBINSON, F.S.A., for his paper on "Decorative Plaster Work: Modelled Stucco Work."

Thanks were voted to the following Member of Council:—

To JAMES DREDGE, for his paper on "The Chicago Exhibition."

CONVERSAZIONE.

The Society's Annual *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday evening last, 17th inst. The courts and corridors of the ground floors, and the galleries containing the Raphael cartoons, the Sheepshanks collection, the William Smith collection of water-colour drawing, the Dyce and Forster pictures, and the Chantrey bequest were open.

The reception was held in the South Court, by the Attorney-General (Sir Richard Webster, M.P.), Chairman, and the following Vice-Presidents and Members of Council:—William Anderson, M.Inst.C.E., F.R.S.; Maj.-Gen. Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Sir George Hayter Chubb; B. Francis Cobb; Sir Philip Cunliffe - Owen, K.C.B., K.C.M.G., C.I.E.; Sir Henry Doulton, James Dredge; Charles Malcolm Kennedy, C.B.; John Biddulph Martin; John Fletcher Moulton, Q.C., F.R.S.; William Henry Preece, F.R.S.; Sir Robert Rawlinson, K.C.B.; Sir Owen Roberts, M.A., F.S.A.

Promenade Concerts were given by the Band of the Grenadier Guards (Conductor, Lieut. Dan Godfrey) in the North Court, and by the Band of the Scots Guards (Conductor, Mr. Edward Holland) in the Quadrangle of the Museum.

A concert of old English music was given in the Lecture Theatre under the direction of Mr. Arnold Dolmetsch. The instruments used were those for which the music was originally written—viz., viols, lute, and harpsichord.

The number of visitors attending the *Conversazione* was 2,000.

Proceedings of the Society.

INDIAN SECTION.

Thursday, May 28th, 1891; The Right Hon. Sir MOUNTSTUART GRANT - DUFF, G.C.S.I., C.I.E., in the chair.

The paper read was—

THE STUDY OF INDIAN HISTORY.

BY CHARLES LEWIS TUPPER,

Chief Secretary to the Government of Punjab.

In beginning this paper, I am anxious to explain that I do not pretend to any better acquaintance with Indian history than is usually possessed by Indian civil servants of the same standing as myself, who have done a good deal of work at head-quarters. I am not, of course, a professional student; I venture to come before you merely as a busy official, who, in an interval of leave, has found time to put on paper some conclusions which have naturally occurred to him in the course of his duties. These conclusions relate to the value of the study of Indian history, to the means whereby it might be facilitated, and to the directions in which it might be profitably pursued. I therefore limit my paper to suggestions bearing upon the study of Indian history; I in no way venture to deal with Indian history itself. Special periods of Indian history, and, still more, any general survey of the vast field of learning which is included under that expression, are best left to competent specialists. Without pretending to any exceptional acquaintance with a subject which it would take a lifetime to know well, and several, perhaps many, lifetimes to exhaust, we may still be able to recognise, and even, in some slight way, to define the value of its study, and to see how that study might be made easier, and, possibly, more fruitful than it has sometimes proved to be. To borrow a happy phrase from Professor Max Müller, I shall refer particularly more to authentic than to constructive Indian history; to the history which has been compiled from contemporary books and documents, rather than to that which is being built up on inferences drawn from archaeological research; from allusions to ancient India in classical writers; and from an examination of the laws, the plays and poems, and the sacred books composed in Hindu times, centuries before the

establishment of Musalmán dominion. And, within the range of authentic Indian history, I shall most frequently have in view the last half of the last century, and the events and tendencies of our own times, and those which immediately preceded them. In the business of administration, the most practical interest necessarily attaches to that portion of the past which palpably affects the present; and of the whole story, I cannot but think that, so much as relates to the last 150 years, is the part which is best known, and—if we look to the probable future of the country—has the most importance.

As regards the literary value of Indian history, its value, that is, as a means of intellectual enjoyment, I wish I could enter an honest dissent from the wide-spread opinion that Indian history is very dull. The brilliant writings of Macaulay, of Sir Henry Maine, and Sir Alfred Lyall, suffice to assure us that it need not always be so; but so long as we consider Indian history by itself—and that is precisely what Sir Henry Maine and Sir Alfred Lyall teach us not to do—I fear that, for those who have no professional interest in its study, nothing short of genius is capable of enlivening it. The great debt we owe to the two writers just mentioned is, I think, that they lead us to look to the character and working of Indian institutions and ideas, more than to the dry annals of Indian wars and dynasties; and in so doing, to compare typical forms of Oriental society and usage with the present and past of the West. Such comparison has an obvious and direct bearing on the discovery or illustration of laws or theories of social progress, and should, therefore, be particularly interesting to learned men in Europe who are engaged on one of the greatest of the intellectual problems of the day: the relation, I mean, between the doctrine of evolution and the successive modifications of human society. Unfortunately, Indian history not only has a poor reputation for interest, but, on first scrutiny, wears a very unattractive guise. I can well remember the dismay with which, when reading for my examinations, I took up the study of the Muhammadan period in Elphinstone. The style of the names—I did not then know a Hindu name from a Muhammadan one—and the geography of the country were alike unfamiliar to me. Many here will recollect how, after the brief episode of Arab conquest in Sindh, the Muhammadan period begins with the thirteen or more plundering expeditions of Mahmud of Ghazni; and how diffi-

cult it is to follow with any interest the fortunes of the half a dozen dynasties—from the House of Ghor to the House of Lodi—when Afghan and Mughal invasion of the Punjab and northern India, complicated by habitual fighting between the Afghans and Mughals themselves, and Afghan invasion of the Deccan, gradually wore down the brave resistance of numerous Rajput and other Hindu states, and substantially though not directly founded that Muhammadan supremacy which has now passed to the British crown. During this period of some three and a half centuries (1186 A.D. to 1526 A.D.), when six successive dynasties exercised various degrees of power in northern India, for—on an average—some 57 years apiece, some events no doubt occurred of lasting significance, as, for instance, the break up of the extensive empire of Muhammad Tughlak; but, on the whole, the details of an essentially Hindu and Muhammadan contest are, I think, wearisome to those who have no hereditary connection, in race or creed, with the combatants on one side or the other. Hallam, sarcastically speaking of the Visigoths in Spain, says he holds the annals of barbarians so unworthy of remembrance that he will not detain the reader by naming one sovereign of that obscure race. Perhaps a good many people who have read Indian history, otherwise than as a matter of choice, have experienced a feeling more or less resembling that which underlies this sarcasm; and others, who have not attempted the subject, may have been repelled from it by a similar conviction of its uselessness. Mere unfamiliarity with names and places is, of course, a comparatively small difficulty which every one has to overcome, here and there, in all serious historical work; but the belief that, in the case of Indian history, it is not really worth while to surmount this difficulty, is an obstacle, not indeed to the progress of Indian historical studies amongst those who have professional reasons for entering upon them, but to the more extended use of facts drawn from Indian sources for purposes of illustration and comparison in the composition of history at large.

Possibly a conviction that Indian history has little use apart from the practical business of Indian administration may arise from the obvious reflection that India lies outside the history of civilisation as understood till a comparatively recent date. We read history with the objects of enlarging our experience and interpreting our own times; our time is that of Europe in the 19th century, and the ex-

perience which is most useful to most of us is that which has been formed by the civilisation of the West. Thus it is that we look back to the ancient cities which dotted the shores of the Mediterranean; to the origin of European literature and philosophy in Greece; to the consolidation of Roman power in Italy, and its spread beyond the Mediterranean coasts; to the gradual decline and fall of the great Roman empire, the incursions and conquests of German tribes, the rise of the church, the growth of feudalism, the breaking up of the feudal and ecclesiastical order, the Reformation, the great territorial monarchies, the beginnings of international law, the constitutional governments and the amalgamation of small states by confederacy or absorption in the great kingdoms or empires of great races. The commanding interest of that absorbing drama never fails; and we feel, and feel truly, that India is off the stage the whole time, and that it is hardly necessary even to know the name of India for the purpose of following the plot.

But there are two reasons why we are no longer willing to limit the history of civilisation to those countries where, in the past, progress has been most rapid, most brilliant, and most secure. Electricity and steam have changed into a single Mediterranean all the oceans of the world. It seems as though the history which posterity will have to tell will either take the continents as the units of its narrative, or will regard the great European states mainly as the progenitors or rulers of states, dependent or independent, in other quarters of the globe. Australia is ours, and part of America. We may almost say that Asia is already divided between China, Russia, and ourselves. Africa is in process of partition amongst the great Powers of the West. Now the experience which Great Britain, in virtue of the possession of India, has gained of the government by a civilised and constitutional country of races far removed from itself in character and degree of civilisation is, I think, likely to prove of very great value not only to Great Britain herself in the career which awaits her, but also to other nations which are, nowadays, setting out on adventurous enterprises similar to those on which we have been engaged for more than a hundred years.

Here, then, is one possible point of contact between the history of India under British rule and that great drama of European progress, of which we may almost say, with Mr. Freeman, that all the past was gathered into

Rome, and all the present springs out of it. Events are enlarging European history and transforming it into the history of the world. Modes of administration and laws—as, for instance, the Indian Penal Code and the constitution of the Indian provinces—evolved in India under the pressure of novel necessities, may yet have a part to play outside the Indian continent. But in another way, we have ceased to regard the history of civilisation as identical with the history of Europe, with Russia and Scandinavia left out. When we take up such books as Mr. Tylor's "Primitive Culture," Sir John Lubbock's "Origin of Civilisation," and Herbert Spencer's "Sociology," we feel that the use of the methods of physical research has created a new conception of history. What, in this connection, we now desire to follow is not the history of particular nations or sets of nations, but the history of the human race. We want to ascertain the general laws of the progress of mankind from the mere savage horde to the tribal stage, thence onward to the agricultural community, to city life, to the formation of states and empires, and the growth of nationalities, united by the bonds of commerce and international law. Now, from this point of view, when we come to regard history as so much material for the construction of working theories of social development, the Indian evidence will, I think, be allowed to possess a very high value. So much of it as we have amassed during the last 150 years is, as a rule, particularly good evidence, because it has been collected by able men, with excellent opportunities of observation, and, in most cases, with no theories to serve. And a portion of its special interest is derived from the very circumstance which may be suspected hitherto of causing a disinclination to examine it. Before 1757, the year of the battle of Plassey, the tide of European civilisation had scarcely affected India. I do not overlook the trading settlements of Portuguese, Dutch, French, and English; the beginning of the French and English wars in the Carnatic; the career of Dupleix; the defence of Arcot: I mean that, up to the time when our countrymen founded a great territorial power, the course of Indian history was directed by events of Indian, or, at least, of Asiatic origin. No European influence sapped the Mughal Empire, or originally prompted its Marhatta foes and usurping governors to accomplish its partition. The whole process of decay and reconstruction was spontaneously at work

before it was given a wholly unexpected turn, by the political achievements of European adventurers. It is due to the isolation of Indian history from the civilisation of the West that we have, as Sir Henry Maine has pointed out, open to view in India a truly ancient society; or, perhaps we should more accurately say, a vast number of societies, standing in different degrees of progress from the primitive tribal type to early mediævalism. Such societies as these, under the direct administration of a strong civilised power, exhibit changes with much rapidity. It is true that a new hereditary character is not quickly acquired, and that we must guard ourselves against forgetting what that character is, merely because a tribe or race can speedily learn to use a new language, or to make the weapons of the law serve such rapacious or vengeful purposes as were often committed, not very long ago, to the Afghan knife, the Sikh matchlock, and the Marhatta spear. But an immediate effect of the contact between late and early civilisation is a change in the type and direction of social advance. The survival of the fittest may be a principle of progress in primitive societies which are left to themselves; but directly you expose such societies to the chemical action of civilised rule, or even of the *débris* of a decayed civilisation, their spontaneous growth is checked or altered, and shapes appear which, without that action, would have been impossible. To this irresistible chemistry of civilisation in juxtaposition with barbarism, the primitive societies of the greater part of Europe have been twice exposed; first, when Roman dominion overspread the tribes to the Firths of Clyde and Forth, to the Rhine and the Danube; and a second time, when the conquerors of the West planted in the detritus of the fallen empire the institutions brought from German forests and wastes by German tribes, partly predatory and partly agricultural. To Roman government, to the Roman influences still deeply at work in the law, diplomacy and religion of some of the foremost nations of the world, the India of the Khalsa, of the Nawabs of Bengal and the Carnatic, of the Nizam and Hyder Ali, of the Peshwa and the great Marhatta houses, owed nothing. Clearly, if we are looking for general laws of social progress, it is profitable to examine societies which have grown up outside the range of preponderating civilisations, and to compare them with societies falling within that range. The simpler growth,

set side by side with the more complex growth, should help us to discriminate between the survivals of primitive times and the lasting legacies of mature civilisation.

In this view the comparison between feudalism and Indian political institutions, not those which we have created, but those which grew up before our time, seems to me to deserve very considerable attention. When I have had the time I have worked a good deal at this subject, and I hope that before many months are over I may be able to publish the results of an inquiry which has certainly been very laborious, and is still incomplete. Here I will only venture to single out for remark two points which are already familiar to those who have been attracted by Indian topics. Sir Alfred Lyall, in one of his admirable papers ("Asiatic Studies," p. 216), points out that though the organisation of the Rajput states is overlaid by feudal growth, nowhere in Rajputana has the system become entirely feudal; that is, "nowhere has military tenure obliterated altogether the original tenure by blood and birthright of the clan." It is not possible exactly to generalise this observation; but I think I may safely say that in the greater part of India, before a new sort of action was set up by British conquest, though there was no perfected feudalism anywhere, there were traces everywhere of tendencies making for feudalism of certain kinds. And the feudal type towards which these tendencies drew, differed greatly in different parts of the country. I have not yet found the contrast between the tie of blood and the tie of the land as the basis of society anywhere so clear as it is in Rajput states. No doubt amongst Muhammadans and Marhattas, Rajputs, and Sikhs alike the land was the foundation of important political institutions. But in the Mughal and Marhatta Empires, and in the Sikh Confederacy, the supplementary bonds of union were those of race and religion, not those of tribal descent. In the India of the decline and fall of the Mughal Empire military tenures abound; we see them in the service *jāgirs* or land revenue assignments of the Muhammadans in the Deccan; in the relations established or maintained between Marhatta chieftains and the Peshwa; in the origin of some petty states in the Central Provinces, in Rajputana, in the Punjab hills, in the Sikh conquest *jāgirs*, in some of the old Bengal *zamindāris*. But military tenures by themselves do not make feudalism. We understand by that expression a polity, what Bishop Stubbs describes as

"a complete organisation of society through the medium of land tenure, in which, from the king down to the lowest landowner, all are bound together by obligation of service and defence." There was a summit of one imperfect hierarchy in the Peshwa, of another in the Khalsa, of a third in the Great Mughal. But in each case the political pyramid was very loosely composed; and in each case, as in Western Europe, the apex tended to vanish into a name, impotent except when politically used to give the semblance of legitimacy to conquest or usurpation. The first point, then, which I here submit is that India, as we found it, was for the most part in a præfeudal stage, with strong marks of incipient feudalism. The second is that the analogies between the dissolution of the Mughal and the dissolution of the Karolingian power, slightly mentioned by Sir Henry Maine ("Early Law and Custom," p. 351), hold good to a remarkable extent, not only in the social effects, which produced a vast number of petty principalities, but also in the actual process by which the change was effected. Both in the completed feudalism of the West, and in the imperfect feudalism of India, there is a double ownership of land. In the West that was, in a juridical sense, created by the voluntary compact between lord and man. In India it sprang from immemorial custom which gave to prince and peasant a joint interest in the soil. Processes starting from these different principles could not be identical; but we can see where they were alike when we compare the benefice changing into the fief, and the fief changing into the principality with the Mughal provincial governorships partly supported by land revenue assignments, with the great Bengal *zamindāris* held by officials permitted by the ruler of the day to exercise nearly all the authority of government, with the *jāgirs* of the southern Marhatta country, and the Marhatta claims over the regions about Baroda, Indore, and Gwalior, both alike the origin of territorial power; and with the numerous small Sikh states that sprang up between the Sutlej and the Jumna, when the vestiges of Mughal rule had been trampled down by the successive invasions of Nadir Shah and Ahmad Shah Durani. An Indian ruler commonly arranged for the administration of the country and provided for his friends by granting what was his to give: the jurisdiction, subject to payment of revenue, as in the case of a *zamindār*; the revenue itself, that is, the king's share of the crop, in money or kind, as

in the case of a *jāgirdār*, who might or might not have jurisdiction. Where the ruler had got the better of a Raja already in possession, it was a usual expedient to treat him as a *zamindār*. The essential political feature of the 18th century in India was the rapid formation of states, large and small, often by the assertion of independence on the part of those who had been governors or commanders under one or other of the two great substantive powers, Delhi and the Marhattas. In the organised provinces of the Mughal empire, the provincial governors, in the Marhatta provinces, the Marhatta generals, in other parts of the peninsula, the so-called *poligārs*—that is, officials of broken empires or states, descendants of old royal houses, robber chiefs, fighting their way up to power—set up for themselves as hereditary princes. There was, usually, no objection to acknowledge some superior—some distant and shadowy Peshwa or Emperor, or puppet Nawab—if the acknowledgment was limited to lip-service and homage, involved no inconvenient claims and no control, and might serve as a local excuse for lucrative quarrels. The Empire of Karl the Great broke up at first into three and then into seven kingdoms, and its dismemberment did not stop there. By the end of 9th century, in what we now call France there were twenty-nine provinces, or fragments of provinces, erected into small states. By the end of the 10th century, instead of twenty-nine small states, fifty-five were fully established. "Every one knows," says Guizot,* "that the possessors of domains and royal offices, that is to say, the beneficiaries and the dukes, counts, viscounts, centeniers, and other governors of provinces and districts, were constantly bent upon rendering themselves independent and hereditary, and assuring themselves the perpetual possession of their lands and governments." If we change the mediæval for oriental designations, and read—for beneficiaries, and others—*jāgirdārs*, *zamindārs*, *pardhāns*, *senapatis*, *subadārs*, and *poli-gārs*, this sentence of Guizot, referring to the end of the 9th century, might be applied with very little further change to India nine centuries later.

Twice in authentic history has a great power, imbued with the legal and constitutional traditions of the West, worked out the problem of governing or controlling in an imperial fashion a vast and varied assemblage of subject tribes,

racess and states. European feudalism resulted from the influx of primitive German tribes into provinces which had taken their political configuration from the enormous pressure of Roman rule. India presents the converse case; the earlier political forms are being moulded to new shapes by the weight of British administration or supremacy. If we may look to Europe of the 8th, 9th, and 10th centuries for analogies with what India was before our day, we must go back to the later Republic and earlier Empire of Rome to see how in a former age men of a civilisation in many points resembling our own dealt with annexed territories and client-princes. Even in the broadest outlines of organisation and history there are some features which immediately strike us as truly alike. The roads corresponding to our railways; the colonies (so far as they were fortified outposts and settlements of veterans, not a concession to the clamour of the mob for lands), and the standing frontier camps, both answering the purposes of our cantonments; the massing of troops on the Rhine and the Danube, as they are massed by us in the basins of the Indus and the Irrawaddy; the diversity of the races brought under Imperial rule, German or Briton differing from Greek or Egyptian as much as Afghans or Belochis differ from Bengalis; the general external similarity of the Roman and Indian provincial systems of government, officers being appointed in the Imperial provinces with much discrimination by the Imperial authority to local administrations for terms of years, subject, however, to increasingly strong control on the part of the central government; the administrative improvements effected as experience was gained in the government of dependencies and of ceded and conquered territories, such as the substitution of fixed payments for tithes, the disuse of the ruinous system of farming the land revenue to companies of *publicani*, and (to use equivalent modern terms) the separation of military command from the functions of a chief and judicial commissioner:—all these are matters which would deserve detailed consideration in any regular attempt to follow out what is, I venture to think, one of the most striking and instructive analogies in the whole course of history. Or, again, if we leave the general military and political arrangements and the relations of heads of provinces to the emperor, and look into the interior organisation of one or two of the Roman provinces themselves, we shall even more vividly realise how like was the work

* "History of Civilisation in France," vol. ii., p. 278.

of the Roman officials to that which has been done, and is being done, by our countrymen in India. In Sicily, for instance, the *prætor* or governor had complete *jurisdictio* with *imperium* and *potestas*; or, as we should put it, the chief commissioner had the military command and the civil and criminal powers of a high court—a combination which is indeed very rare with us but occurs occasionally, as in the Khyber Pass during the last Afghan war. There was a *quæstor* at Syracuse and a *quæstor* at Lilybæum; owing to the union of civil and military functions the *quæstor* was paymaster of the forces; but, to use a catcherry technicality, on the civil side he levied the revenue not farmed to *publicani*; controlled the *publicani* so far as he could, and forwarded the proceeds of collections, with the accounts, to the senatorial treasury. The chief commissioner of Sicily, we may say, was thus assisted by two financial commissioners, who were also military paymasters and civil and military accountants-general. The regulations of King Hiero for the collection of the tithes were carefully preserved, just as we often hear of the maintenance or re-introduction in particular tracts of a native revenue system. Where we deal with villages and *parganas*, *jâgirs* and *zamindâris*, the Romans dealt with towns and town lands, and communities attached to towns, or with towns taken as local centres for a number of tribes or clans. Seventeen Sicilian towns forfeited their land, which was restored to the possession of the occupants subject to tithe and grazing dues. Five towns paid no tithe; they were, as we should say, *lâkirâj*, or held revenue free, or in *jâgir*. Three towns were acknowledged as *federate civitates*, which means, if the Sicilian arrangements were identical in this respect with those of Italy, that the cities were treated like petty native states. Roman laws did not run in them unless introduced by their own act, and they were required to supply a contingent, if necessary, to the forces of the paramount power. How familiar are we in India with the laying out of a province in this fashion—in revenue-paying lands, in lands held revenue free, and in little rulerships retaining various measures of autonomy. If we go eastward under the empire, we meet with even more striking likenesses between the present and the past. Egypt was in a very special sense an Imperial province. Under the republic the Roman theory was that the provinces were *prædia populi Romani*—the estates of the Roman people. But Egypt, from the time of Augustus,

was regarded as the patrimony of the emperor for the time being, not indeed his private property, but a domain passing from emperor to emperor, as though he had been a corporation sole. The authority and patronage of the senate were jealously excluded; senators appear to have been forbidden the country; and the prefects of the emperor, who ruled as successors of the Ptolemies, were of equestrian not of senatorial rank. Besides the prefect, there was a *juridicus Ægypti*, and an *idionotus ad Ægyptum*, "a supreme official for justice, and a supreme finance administrator,"* both likewise of equestrian rank and Roman citizens. There were three territorial divisions, practically Upper, Lower, and Middle Egypt, each under an *epistrategos*. There were 36 (afterwards 47) *nomoi*, or districts, the *strategos*, or district officer, being an Egyptian or Greek. I need not go into further detail. Anyone who has done administrative work in India will see at a glance that it only needs some slight alterations of scene, and some changes of properties and of costumes in the principal parts, to put Roman Egypt on the stage as a British Indian Province. Some particularly strong Viceroy, we will say—one who exaggerates the more trenchant qualities of a Dalhousie—annexes, 50 years hence, a new territory. The revenues of the acquisition happen to be of the utmost consequence to the stability of the finances. The Viceroy, for this and other reasons, resolves to keep every important appointment in the country in his own hands, and to take every possible precaution that the administration shall be conducted in accordance with his personal views and projects. Determining to maintain, in great measure, though, doubtless, under very strong supervision, the native revenue management, he organises a mixed commission of staff corps officers and natives: the offices of chief commissioner, the judicial commissioner, and the financial commissioner being reserved for the staff corps, and the appointments in these cases being made by himself. He allows 36 district charges and three commissionerships. Strongly backed by a ministry having entire confidence in him, he treats the new province as a scheduled district, and, with the aid of the chief commissioner, enacts for it, under the Statute of 1870 (still in force), and without the intervention of the Legislative Council, such regulations as are necessary. Even in executive matters, he does not permit the

* Mommsen: "The Provinces of the Roman Empire," vol. ii., p. 247.

executive council to interfere, dealing with all references from the new province through the foreign department, of which he holds the portfolio. I need scarcely assure you that no Viceroy could be so grasping of patronage or disdainful of his constitutional advisers. But, then, no Viceroy is a Roman emperor; and I have imagined this description for the purpose of bringing out points of difference, as well as points of similarity. The similarity extends to the incidents of the play, no less than to the caste] and get up. We read in Mommsen* of a big frontier raid, explained by the culprits as provoked by the ill-treatment they had sustained at the hands of the district officers, regarded by the Romans themselves as due to the absence of Egyptian troops in Arabia and the hopes of the predatory shepherd tribes that they would be able to plunder with impunity. In Roman Egypt, as in British India, the local officer could not but be painfully alive to the great importance of sacred animals, and the bitterness of religious disputes. In Egypt, Mommsen tells us, "the Community of the Hound, in defiance of the Community of the Pike, consumed a pike; and the latter, in defiance of the other consumed a hound; and therefore a war broke out between the two nomes [or districts], till the Romans interfered and chastised both parties."† Such incidents, he adds, were of ordinary occurrence in Egypt. With a different dash of local colour, they are of ordinary occurrence in British India; only we must say, "riots between Hindus and Muhammadans," instead of "wars between two nomes." Almost any officer of a dozen years' experience, certainly in the Punjab, probably also in the North-West, could name three or four towns, where, within his own recollection, disturbance had occurred involving such incidents as the flinging down of animals' tails before a Hindu religious procession; the public or semi-private slaughter of a cow by Muhammadans at the Id; the placing of a dead pig in a mosque used by Muhammadans; or the throwing of bones of cattle into wells used by Hindus.

I need not say more to show that the analogies between British Indian and Roman rule will repay investigation. The comparison cannot fail to interest those who have studied either or both of the two things. I do not, however, advocate this line of study merely as an intellectual pastime for the leisure of scholars. The principles of evolution apply, as I believe, to

both law and administration. There are sound scientific reasons for comparing the growth of Roman law with the growth of the Anglo-Indian codes, and the changes in Roman provincial government which occurred from Cæsar to Constantine with our developments of system, from the desperately crude machinery which was always being pulled to pieces and altered by our early governors to the present administrative manufactories, elaborated on scientific plans, for the outturn, with the maximum of division of labour, of a plentiful supply of Acts, and an appalling multitude of decisions and despatches. Men of my profession, as most of them are well aware, may find Roman studies, when they have the time for them, not without use as a corrective to any narrowness of view which may result from too exclusive a familiarity with one set of bureaucratic experiences. And I see some political advantage if the attention of Indian educational authorities and of our young native fellow-subjects, who turn with commendable thirst to the springs of Western learning, be directed to a world like ours of to-day, in which other governors and administrators met, with civilised skill, tasks as complicated as those which abound in modern India. If the Roman Empire be compared with the British Indian Empire, I have absolutely no fear of the result. I commend to the consideration of hostile speakers at native societies, and hostile writers in the Indian vernacular Press, the innumerable slaves and *coloni* attached to the soil on the broad estates of Roman proprietors; the *ergastula*, or underground rooms, in the Roman farm-houses, where "those slaves who were kept in chains lived, worked, and were tormented";* and, worse even than slavery and the lash, the spectacle of fashionable Rome gazing, for amusement, on the detestable bloodshed of the gladiatorial arena.

If it be admitted that the systematic comparison of the Indian and Roman Empires and of Indian feudal tendencies and European feudalism are desirable ends, it is clear that in efforts to facilitate the study of Indian history we should have as one of our aims its greater accessibility to European scholars. I have no space here to discuss the possible want of a general history of India, which shall be full, readable and sound, and not too highly specialised either in plan or in the use of technical expressions. It is no secret that Sir

* "The Provinces of the Roman Empire," vol. ii., p. 275.

† *Ibid.*, p. 261.

* Seebohm: "The English Village Community," page 263.

William Hunter is engaged on a general history of India, and I am sure that he will have the most cordial wishes of this Society for his success in so onerous a task. Such an undertaking, vast in itself, postulates an immense amount of preliminary labour in the judicious selection from and arrangement of an enormous mass of material. Some of that labour is well in hand already. Under the superintendence of Mr. F. C. Danvers, who gave interesting details of the work in a paper read before this Society on the 19th January, 1890, no less than 3,802 volumes of India-office records have been examined and completely arranged. Omitting an immense amount of scrutiny and classification still in hand, 914 other volumes of records in the India House have, under the same superintendence, been collected from various quarters, arranged, bound, and reported on. Many of these records relate to Java, Sumatra, Borneo, and other places outside India. Nor is progress in preliminary labour limited to work in the India-office. The Government of India, with the view of saving from the destructive ravages of the climate and insects valuable selections from the vast stores of manuscript records in its possession, has lately obtained the sanction of the Secretary of State to the appointment of Mr. Forrest as Director of Records. This practically amounts to putting a peculiarly competent officer on special duty for an unlimited, time for the purpose of preserving and making accessible unique historical materials. Mr. Forrest, in his three massive volumes of correspondence of the time of Warren Hastings, has given promise of the excellent work which he is likely to do.* And we owe something here to Professor Sidney Owen, whose "Selection from Wellesley's Despatches" I would name with grateful acknowledgment. More works of that description appear to me to be required. I venture, moreover, to attach very special importance to those contributions to the study of Indian history, for which we are greatly indebted to the insight, impulse, industry, and supervision of Sir William Hunter. I do not refer merely to the "Imperial Gazetteer." I think the whole set of the "District Gazetteers," compiled, in some cases, by Sir W. Hunter himself, and in most cases by a number of officers following his plans, ought to be placed in every important

public library. The historical sketches of particular districts, in many of these volumes, are of great value; and the political and ethnological information they contain is likely to prove of the greatest service to those who are engaged in the study of the growth of social and jurial institutions. Mr. Hewitt, the Deputy Secretary to the Government of India, in the Home Department, to whom I wrote on this subject, has lately informed me that all the "District Gazetteers" have now been completed, with two exceptions: (1) there is no "Gazetteer" for the town of Madras or the district of South Canara; (2) separate "Gazetteers" have not been issued for the political agencies of Central India; but in the case of many of them, the information compiled was sent to Sir W. Hunter, who incorporated it in the "Imperial Gazetteer." These remarks include Lower but not Upper Burma. The completion of these "Gazetteers" cannot be too widely known in the fields which Sir Henry Maine and McClellan have marked out, and in which Mr. Seeböhm, Mr. Gomme, and others are now labouring.

I am also indebted to Mr. Sime, Director of Public Instruction in the Punjab, for a return of the text-books of Indian history now in use in Indian schools and universities. I append a part of the return to this paper, in case any here may wish to discuss the historical courses of Indian universities. In Indian schools the principal Indian text-books of Indian history prescribed are those of Sir Roper Lethbridge, Sir William Hunter, Mr. Talboys Wheeler, and Sir G. W. Cox. I do not myself purpose to remark on any of these text-books at present.

The "Gazetteers" have been a natural outcome of administrative necessities; and, if I may venture, without impropriety, to say so much of one who has retired, after attaining great distinction, from the service to which I belong, it is mainly due to the insight of Sir W. Hunter that these necessities were recognised, and that they have been met so well. Part of the value of the "Gazetteers" consists, I think, in their close local application. They serve to remind us of the immense variety of different parts of the country in race, history, and tradition. I do not think that the strong, centralising administrations of India, always inevitably making for uniformity, would deny that they may well be reminded occasionally of that elementary fact. Fortunately, what I may call the spontaneous development of Indian historical works, or reports, has followed in a

* "Selections from the Letters, Despatches, and other State Papers preserved by the Foreign Department of the Government of India, 1772-1785." Edited by George W. Forrest. 3 vols. Calcutta, 1890.

remarkable way many of the great territorial divisions. In Mysore and Southern India we have Wilkes and Orme; for the Bombay Presidency there is Grant Duff's "History of the Marhattas;" and Elphinstone's invaluable report on the territories conquered from the Peshwa; for Rajputana there is Tod, and there is Sir Alfred Lyall's "Gazetteer;" for the North-West Provinces and Oudh we have parts of Elphinstone, Mr. H. G. Keene's "Mughal Empire," Sleeman, Mr. Irwin's "Garden of India," and the Oudh Annexation Blue-book; for Bengal there is the Fifth Report and the voluminous literature of the Permanent Settlement; for the Punjab there is Cunningham's "History of the Sikhs," Prinsep's "Origin of the Sikh Power," and Sir Lepel Griffin's "Punjab Rajas." This list is, of course, very far from being exhaustive, but I give it to call attention to a tendency which appears to me to deserve encouragement and furtherance. Works like the "Punjab Rajas," which is a systematic history of the relations between the British Government and the principal Punjab native states, might, I think, be undertaken with advantage for some other provinces. There has appeared no general work on Central India since the publication of Sir John Malcolm's Memoir. The talented and lamented Abernethy Mackay was engaged on a work of the kind, but unhappily died before completing it. This is a want which might well be supplied.

Special studies of particular provinces are, however, of more value to administrators and students of social progress than to historians who might use Indian facts to illustrate European learning. There is necessarily no short cut to a general knowledge of Indian history; but I have two suggestions to offer, by way of making the road to that knowledge less difficult than it is just now. I think that we require (1) a good biographical dictionary of India, and (2) an Indian *Sprünner*, a good historical atlas. My experience is that historical information deposits some of its most durable accretions about the careers of remarkable people, and the distinctive events occurring in particular tracts of country. In suggesting the compilation of an Indian biographical dictionary, I have in view not only the work of those who, engaged upon the history of other countries, can spare but a short time for the collection of illustrations from India, but also the desirability of keeping fresh in the minds of educated men in India, native and European, the great traditions of impressive

personal character, of which the history of that country is full. The larger compilations, such as the "National Dictionary of Biography," are not accessible in India; and Indian officials of all races lead for the most part a roving life, shifting on leave and transfer from place to place, and often camping out for long seasons, so that they have, as a rule, neither the taste nor the chance to carry about with them more than a few handy volumes. We should have, I think, a sound work, which would stand the regular student in good stead, and which would have literary merit enough to be a pleasing companion to a district or settlement officer, when he closes his tent of an evening after the turmoil of the day. A great deal, of course, has been written on Indian biography; there are many lives of particular eminent men, of Lord Lawrence for instance, of Clive, Warren Hastings, and many others; and there are several works of the type of Sir John Kaye's "Lives of Indian Officers." But after search in several libraries I have been able to find only two biographical dictionaries which I need notice here. One of these is the "Oriental Biographical Dictionary" by the late Mr. J. W. Beale, edited by the Asiatic Society of Bengal under the supervision of Mr. H. G. Keene. This work is no doubt very valuable to students of Oriental literature. But it includes the names of literary and other men from many Muhammadan countries, and with a very few exceptions it omits Europeans. Many of the names also of poets, historians, physicians, and the like would possess too little general interest for insertion in such a work as I suggest. Mr. Beale was a clerk in the office of the Board of Revenue of the North-West Provinces, when Sir Henry Elliot was secretary, and probably helped Sir Henry in working up his Muhammadan historians. In the preface of the dictionary indulgence is asked, because Mr. Beale never was in Europe and never enjoyed the use of a complete library; and Mr. Beale himself noted that the work should be considered as a nucleus to which those with access to other sources of information might add new materials. Many of the articles would be very useful in working up a dictionary limited to India and Indian history, but including all names which are really of general interest. Here no difficulty would occur, as the manuscript and copyright of the "Oriental Biographical Dictionary" have already been acquired by Government. The other dictionary is called "Men whom India has Known." It was compiled by J. T.

Higginbotham, and published at Madras in 1874. It has certain merits, and may be described as a useful volume for an editor's table in an Anglo-Indian newspaper office. Such literary merits, however, as it possesses are not great; and (1) it is not up to date, the plan of the book having excluded men who were still at work in India in 1874; and (2) the general absence of references to authorities makes it practically useless for purposes of study. I may add that this work has not, so far as I am aware, established itself as a recognised book of reference in India. But in bringing out a new Indian biographical dictionary, I think it would be well to secure the copyright of this Madras book, and to use it as part of the material for the new work. My idea would be (1) to make out a list of names, native and European, which should be included in the proposed dictionary, giving against the names, where this could be done quickly, references to works in which the needful information would be found; (2) to circulate this list to provincial governments and administrations in India, with the request to add any further names or references which local information might enable them to supply; (3) to divide the work of writing the biographies amongst fifteen or twenty competent people in India and England, at least one writer being allotted for each province; (4) to secure uniformity of design and execution, and due proportion in the length of articles by the appointment of an editor charged with the whole control and responsibility. I think the book should be a Government book, because publishers cannot be expected to enter on a project unlikely to pay; and because the Government could best secure the services of the most competent men for the biographical notices. In the case of living persons, the India-office Compilation gives a detailed list of services, which is all that is required. On the death of any eminent Indian personage, native or European, the Government of the day would decide whether his biography should be added to the rest; and revised editions should be issued from time to time, as necessary.

An Indian historical atlas should, I think, be brought out by the Indian Government. The reasons for not leaving the work to private enterprise are the same as in the case of the proposed dictionary. Moreover, I think it improbable that any private firm could do the work as well as it could be done by the office of the Surveyor-General at Calcutta. I can best

explain the project I have in view by enumerating briefly some of the maps which, I think, a good Indian historical atlas ought to contain. It should begin with a map of the present distribution of languages in India, because, language is one guide—not the only guide, nor an infallible one—to distinctions of race, and ethnology lies at the root of history. Next, should come maps showing the probable course of the invasion of Alexander, and the classical and modern names of Indian places mentioned in classical authors. Then there should be at least one map of Southern India in ancient times, showing, so far as known, the probable boundaries of the so-called Dravidian kingdoms of Chola, Chera, and Pandya. The empire of Muhammad Tughlak should have a map to itself, and should be followed by a series of maps, to illustrate its dissolution. These should include the Bahmani kingdom of the Deccan, the kingdoms formed out of the Bahmani dominions and the Vijayanagar Empire south of the Kistna, which held the Deccan Muhammadans in check for two centuries. I would suggest also maps of (1) India at the accession of Akbar; (2) the provinces of the Mughal Empire, as shown in the *Ayin-Akbari*; (3) Southern India, to illustrate the Wars of the Carnatic; (4) India before the battle of Plassey; (5) India in 1765, the year in which the acquisitions of Bengal, Behar and Orissa, and the northern Sirkars, were confirmed by imperial *firmán*; (6) Southern India in 1792, after the first partition of the conquests from Mysore; (7), (8), (9), (10) India at the close of the administrations of Lords Wellesley, Hastings, Dalhousie, and Dufferin. If to these were added special maps to illustrate the rise of the Marhattas, the rise of the Sikhs, and the two Afghan wars; and if on the face of each map were given the references, with chapter and page, to the passages in accessible works which would explain it, I believe that a better general idea of the course of Indian history could be gathered in three or four days from such an atlas, than can be formed after weeks or perhaps months spent in the perusal of voluminous histories.

This concludes the practical suggestions which I have to offer just now. A sketch like this paper, which merely skims a small part of the surface of a great subject, necessarily omits far more than it contains. No attempt has been made to exhaust any topic touched upon; the object has been to suggest some trains of thought and to propose one or two practical measures; and if the

suggestions offered are held to deserve consideration and discussion, the aim in view will have been attained. I will end by saying that the study of Indian history, appears to me to possess some political advantages to which I have not yet referred. Correct knowledge of the facts of Indian history, and sound opinions on the characteristics of its course will, in more ways than one, lighten the vast burden which has been laid upon the British nation by the responsibilities of Indian Government. In the case of educated natives of India of all classes and races, whether in the service of Government, in the enjoyment of independent means, or in the practice of professions—from self-made Bengali pleaders to Punjab chiefs, from Marhatta Brahmans to Muhammadan judicial officers—it is hard to exaggerate the importance of true information as to the state of India before British rule, and the circumstances which irresistibly led to British supremacy. Our native fellow-subjects often judge our measures and morality with a severity which Oriental etiquette teaches them, in official and private intercourse, scrupulously to conceal. I do not deprecate any severe judgment which is essentially just; but I urge that knowledge is the parent of both justice and charity. In proportion as the past is more distinctly realised, a juster and more charitable view will be taken of that present which has

sprung out of it. In the close juxtaposition of races and creeds which develops so many points of possible conflict, it is a consolation to reflect that there is one country, the realm of reason and knowledge, of which all men may be fellow citizens, who have the perseverance and capacity to tender to those sovereign powers their honest allegiance. Agreement in a true and just view of past events, ought at least to facilitate harmony between educated India and the Indian services. As for those services themselves, the political value of Indian history for them is manifest, well recognised, and needs no description. In Indian history are laid the foundations of administrative continuity, of competent acquaintance with Indian races and creeds, territories, and institutions. But there is a political value of the study of Indian history, in connection with the duties of the services, which is not quite so obvious. The spread of that study may affect the amount of encouragement they receive to sustain them in work which, whatever else it may be, is undoubtedly anxious and arduous. We are the servants of the British people; and, in proportion as the past and present of British India are better understood at home, we shall feel that we have the better chance of obtaining what is our greatest honour and our best reward, the sympathy of our fellow countrymen.

APPENDIX.—COURSES IN INDIAN HISTORY PRESCRIBED BY THE INDIAN UNIVERSITIES.

	Entrance Examination.	First Arts Examination.	B.A. Examination.	M.A. Examination.
Calcutta University	"Brief History of the Indian People," by W. W. Hunter.	Nil.	1. "Short History of India" (British period only), by Wheeler. 2. "History of India" (Hindu and Muhammadan periods), by Elphinstone.	Nil.
Madras University	The History of India. The whole.	Nil.	Nil.	History of India. A selected period or subject.
Bombay University	Elementary History of India.	Nil.	History of India in the 16th, 17th, 18th, and 19th centuries, down to the overthrow of the Peshwa. Texts—"History of India," by Elphinstone; and Mill's "History of British India."	Nil.
Punjab University	Outlines of the History of India.	Nil.	"The History of India," as in Elphinstone and Marshman, vol. ii.	The History of India, including an acquaintance with the works of native historians, both Hindus and Muhammadans. Elphinstone and Elliot.
Allahabad University....	"The establishment of British Rule in India," by Sir G. W. Cox.	"College History of India," by Talboys Wheeler.	"History of India," by Hunter.	Nil.

DISCUSSION.

SIR ALFRED C. LYALL, K.C.B., K.C.I.E., desired to express his high appreciation of Mr. Tupper's excellent paper, which showed remarkable power of comprehensiveness, drawing the outlines and marking out the salient points of a vast and complicated field of history. He said the difficulty of the subject with regard to late Indian history lay in the wealth of material—one was liable to be blinded by excess of light. With regard to the earlier part of the history, it was exactly the reverse; in fact, India had no history at all, as we now understood the term, and one reason why Indian history and all Asiatic history was so uninteresting, was that it generally consisted of a few annals; there was very little movement in their civilisation or development of the art of government, it was simply one despotism succeeding another, and at the beginning, therefore, one could only pick out the broad lines. He agreed with what Mr. Tupper had said as to the working plan to be adopted, and he observed with much satisfaction that the paper laid stress on the remarkable analogy between the Empire of England in India and the old Empire of Rome. Anyone who considered the subject must be struck with this historical parallel, the truth being that similar circumstances and similar needs produced similar methods of administration. The analogy was most striking, moreover, in the case of the Asiatic and African provinces of ancient Rome, as was clearly brought out by Mommsen. The account of the way in which, in Africa, camps grew into towns and cities, anticipated very curiously what had occurred in British India. As far as he could make out, feudation was the natural result of the breaking up of a great empire which had previously broken to pieces ancient tribal groups and small kingdoms. The people then rallied together under any leader they could get, and co-operated for self-protection, the small man assigned himself to a larger man, he to one above him, and so they all held together. That was clearly what had begun to take place in India in the 18th century when the Mogul empire fell to pieces, and what prevented the consolidation of some such system in certain parts of the country was the introduction of the English power. Throughout the 18th century the one thing which shaped the history of India and Asia was the gradual predominance of European power in India, and from that point all modern history must begin, as from that time all the earlier institutions and many of the earlier ideas were gradually swept away. No time should be lost in collecting all the materials which existed, and making them accessible to all, especially to the Indians themselves, for he quite agreed with Mr. Tupper that there was no sounder way of explaining and justifying the English empire in India, and reconciling the ideas of the two nations, than by a complete and impartial study of Indian history.

MR. W. S. SETON-KARR said Mr. Tupper was another example of the truth that the most busy men were those who found most time for work outside their ordinary avocations. He had not alluded to the well-known paradox of Mill, that a man was all the better qualified to write about a country he had never visited and was not likely to see; but he must have perceived another danger, that of Indian history and Indian politics being written by men who took a three months' tour in the country, and came home knowing everything about the exceedingly difficult problems which men like Sir Alfred Lyall were hardly able to solve after thirty years' experience. With reference to what had been said about the quarrels between Muhammadans and Hindus, he might mention that only last week, in Calcutta itself, a riot had occurred, owing to the desecration of a mosque by a person who was put down as a Hindu gentleman of the name of Dey, but who was, no doubt, one of the writer class of Bengal—one of the eight branches of the second rank—the word "Dey," of course, denoting only the caste. In connection with the question of maps, he might mention that there was a very excellent little book on Indian geography, by Dr. G. W. Smith, which contained about 5,000 or 6,000 names, brought up to date; and he was astonished to find that in it there were hardly half-a-dozen misprints. He would not go so far as to say that Indian history could not be made attractive to the general reader, for there were living proofs in that room that it could be written so as to attract the attention of intelligent persons; but the early history of India could never be very attractive. Its various revolutions and changes of dynasties never affected the civilisation of Europe, and only possessed an interest for the Indians themselves. But, when you came to the last century, you were overwhelmed with a mass of evidence, which required a great deal of care to sift. In time, no doubt, men like Mr. Tupper and Sir William Hunter would sift the wheat from the chaff, and produce histories and biographies which, if not attractive to the average British householder, would commend themselves to all Indian students.

MR. DANVERS said it might be supposed that they possessed at the India-office all the materials necessary for writing the history of India, but that was not so. In early days it was thought desirable to make room for new records by getting rid of the old ones, and those entrusted with the duty of selecting what should be sold as waste were evidently not so intelligent as some of those who bought it, for though the purchasers were under a bond to destroy it, they evidently saw the value of the materials in their hands, and many of those papers found their way to the British Museum, and were preserved. Even the materials at the India-office were not yet in the shape in which he hoped they would be before long, and besides those there were many papers at the British Museum which the author of a history of

India should consult. There were also a number in the Record-office, and besides that, as the report of the Historical MSS. Commission showed, there were many papers of great value relating to India in private collections. At one time he was ambitious enough to think of writing a history of India himself, but he soon found that it was a task far beyond his powers. It required a person who had nothing else to do, and a person intimately acquainted with India, its people, and customs. He must not allow his political opinions to bias him in what he wrote; and when he came to the India-office he must not rest satisfied with the volumes of extracts and selections made by Orme and Wilkes for the purpose of their histories, but must go to the original documents in the basement and search for himself. Again, he must not expect that the work would be remunerative in comparison with the time and labour he would have to bestow upon it. He could only say, in conclusion, that he should be very glad to render any assistance in his power to Sir William Hunter or any one else who would take up the work.

General MACLAGAN said that Mr. Tupper's thoughtful paper, though restricted in its scope, covered a large area, and there were few persons directly concerned with India who would not find in it much that is instructive and helpful. He (General MacLagan) had only to offer a suggestion. Mr. Tupper had noticed some *desiderata* in the helps to the study of Indian history, and proposed the preparation of two new works to supply the chief wants, (1) an Indian biographical dictionary, and (2) an Indian historical atlas. In addition to these, he (General MacLagan) would suggest a classified catalogue, with notes, of books of European authorship, which dealt with the history and geography of India. Of European authorship, for of native histories of India, of the Muhammadan period, there was not only that abundance of books of which Sir Alfred Lyall had spoken, but also an index work which, for the present at least, excellently takes the place of a historical catalogue, and is much more—that rich storehouse of historical material, collected by Sir Henry Elliot, with the additions made by the editor, Professor Dowson, now bearing the title, “History of India, as told by its own Historians.” For the history of India in preceding times we have not similar material. The Hindus have not in days past been a history-writing people, as we understand history-writing. Some history may be extracted from their great poems and their ancient sacred and philosophical books, but there is little of designed historical narrative except the metrical history of Kashmir. This is the more remarkable as there is such a wealth of Sanscrit literature of other kinds, to which it is pleasing to know that greatly increased attention is now being paid by Indian people, under the influence of the active labours, during the last half century, of

Sanscrit scholars in Europe. It is a cause of much satisfaction that this activity in the pursuit of Sanscrit learning, in the East and in the West, is strengthening the literary fellowship, while progress is being made in strengthening the social ties between the people of India and ourselves. In the absence of historical material in the form of books for the knowledge of India in Muhammadan times, recourse is had to what Mr. Tupper, quoting Max Müller, has referred to as constructive history, that is, history gathered from coins, inscribed pillars, writings on stone tablets in walls, and inscriptions graven on rocks. And this knowledge has to be furnished by the researches of specialists. A partial catalogue of the kind now suggested, called by its author a tentative list, relating to one small portion of Indian history, was prepared by the late Mr. Arthur Burnell, of the Madras Civil Service. A short note after the name of each book gives needful information regarding it. Very ample accounts of each history and historian of the Muhammadan period are given in Sir Henry Elliot's work, which is a copious store of material for history. It has been a cause of some regret that it was not carried on in the manner in which it was begun by Sir Henry Elliot himself, and also that it has received a scarcely approximate new name. The plan of the author, shown in the first volume, published in Calcutta (all that was issued under his own direction), was, along with the account of each history and translation of short extracts, to give specimens of these passages in the originals, from which readers might both learn something of the style of the authors, and understand the manner of the translations. The book is not, as it is now called, a “History of India,” as told by its own historians. It contains many fragments of history, and sometimes repetitions of these, as the same events are narrated by different writers; but these fragments are not so connected as to make history. He (General MacLagan), however, felt conscious of something like ingratitude in saying even a single word against a book so full of information, so excellent and so serviceable. He would only re-state that the kind of work he desired to suggest was a classified catalogue, with notes, of European books, containing matter relating to the history and geography of India.

Dr. LEITNER said there was so much in what General MacLagan had said, that he should like to emphasize it. If you went to what was called authentic history, as distinguished from constructive history, you had to depend, as the native historian would say, on the pen of folly or falsehood, writing on the parchment of endurance. In other words, anything might be written to please the governors, or, as in this country, to please the public; but when you went to the materials of constructive history, and saw how people gave their daughters in marriage; how they buried their dead; and how they commemorated great events; or looked at the rocks of Asoka, at coins,

and inscriptions, you had real history. In fact, the only authentic history, as regarded India, was constructive history. If Hindus had to depend on written history, they would practically have no history at all. It was not merely what the historian said—and even in Europe he sometimes said what was not true, with regard to events—but what he did not say, that often constituted history. There were those incidental things which the historian fancied were of no importance which guided the inquirer in examining whether the alleged facts were such or not. This information must be looked for in directions indicated by General Maclagan; and in customs, the poems to the various deities, the forms and colours of those deities, would be found the only true early history of India on which one could build. As Mr. Danvers had very rightly said, they should not take extracts written by modern compilers, but go to the so-called original European sources; and he would go a step further, namely, to the native sources, and say that the Indian historian should study that particular part of India with which he was about to deal, separately, locally, thoroughly, and—above all—linguistically, bearing in mind the genius of the language in which the native historian wrote. There again he could not quite agree with Sir Alfred Lyall, for though the native historians might not be very interesting to listen to, they were interesting and valuable to the student. For instance, in the case of the Arabic writers, nothing truer, nothing more commendable, could be imagined than the mode in which they proceeded. When a date or a name was mentioned, it was repeated and fully spelt out so that there could be no mistake about it, and that was a matter of no small importance, when the phonetic changes which often followed the historian's epoch were considered. Again, when a fact was brought forward, the writer pointed out how such a fact could be established, and laws were laid down with regard to the different degrees of authenticity in traditions, chiefly religious, but also relating to law, history, and customs. That authenticity, even with them who were the most authentic historians, was established by the constructiveness of human nature, the fallibility of which could only be judged by surrounding circumstances. Amongst the Persians, the adulation of the writers induced them to say many things in favour of those in power, and possibly the same thing might happen now-a-days in India. If biographical dictionaries were written at the expense of Government, and posthumous reputations were to be manufactured in the future at the cost of an appreciative Government, it was probable that those who pleased the Government might receive better notices than those who did not, and it might also be that historical events of importance might be coloured, however unintentionally, by the liberal view taken, say, by an appreciative viceroy. What did the Persians do? Although the language in itself was so elegant and courtly,

and often passed over unpleasant facts in a mode which was not strictly accurate, yet he who read between the lines would often find indications in the language of the Persian historian of the real truth which lay beneath; and it would not be impossible to find similar indications in some of the complimentary addresses of the natives of India to ourselves. The Hindi language was plain and straightforward, with no circumlocution or generalising, such as enabled some European historians to say the thing that was not. With regard to the analogy between the English and the Roman Empire, the fact was that human nature was alike, and things would repeat themselves, and would be capable of comparison. There were, of course, coincidences, but in dealing with a different country, one should dwell rather on the differences. In personal intercourse, we should try to find as much common ground as possible, but in a philosophical disquisition, while preserving a basis of sympathy, that which made one country differ from another should be considered, before analogies, mainly based on the accident of one's own education were sought for. If Indian history was not read, it was for the same reason that many people, when they saw Alison's "History of Europe," felt giddy; it was too much for them. If they could read something about the peculiarities of Kashmir shawl weaving, many of our enterprising tradesmen would read the volume. An interesting book might be made of the songs of Kattiawari or the traditions of the hereditary minstrels. One of his own Chuprassis could give his "authentic" genealogy for over 1,000 years, on a scroll that was many yards long; people might smile, but he believed that this scroll was more authentic than a good deal which passed as such, because it was based on actual marriages and births, recorded as a sacred duty. When one came to authors like the Chairman, who had dealt with one portion of a great subject, and had done it well, there was something to go upon. Mr. Tupper, who was a bright example amongst civilians, very few of whom knew one-tenth of what he did, should, he thought, have recommended the study of native Indian historians, but when he read the scheme of historical study in the Indian universities he could not but feel great disappointment. The only thing he found as the remnant of many years' effort of his own in the Panjab University was a subject in the M.A. examination which no one cared for, "The History of India, including an acquaintance with the works of native historians, both Hindus and Mohammadans." That was only gained after a long struggle in the very home of those historians; and it was put at the very end of the educational course. What was there in the other universities? It was enough to make one weep to look at the textbooks given to the men who went up for history in the B.A. course. Could such books be called histories? Mr. Tupper, at the conclusion of the paper, spoke of the feeling of sympathy which would be the reward

of the future historian of India; and that was, no doubt, a desirable object to strive for; but there was something still more laudable, which should, indeed, be the historian's only aim, and that was truth.

The CHAIRMAN, in proposing a vote of thanks to Mr. Tupper, said there was no part of his very valuable paper which had interested him more than the comparison he drew between the way in which the Romans governed their provinces and the way in which England ruled India. This was one of the latest subjects which attracted the attention of Mr. Mount-Stuart Elphinstone; and in one of the last conversations he had with him, he was full of questions on the subject. Unfortunately, in those days, the great work of Mommsen did not exist. He trusted that, some time in the course of the next century, pretty far on, it might be the good fortune of Mr. Tupper to communicate to his illustrious predecessor in the Elysian fields some of his conclusions on this matter.

The vote of thanks having been carried,

Mr. TUPPER, in reply, said it had given him the greatest pleasure to find that the views he had formed were endorsed by Sir Alfred Lyall. He had lately been over that portion of the ground, and entirely agreed that it was in the Asiatic and African provinces that the strictest analogies were to be found between the British-Indian and Roman empires. He had noticed, since writing the paper, the case in Calcutta to which Mr. Seton-Karr had referred. General MacLagan's suggestion of a classified catalogue with notes, was a very valuable one. He thanked Mr. Danvers for the kind assistance he had given him in preparing the paper, and his observations on the qualifications required of an Indian historian were deserving of very careful consideration. He had listened to Dr. Leitner's remarks with much interest, but he did not think there was any real difference of opinion between them as to the value of constructive and authentic history respectively. He had simply adopted the terms as used by Professor Max Müller to point out the difference of method in which history might be written, and did not mean to raise any question as to the comparative value of the two classes of history, or to say that because history was constructive it could not be authentic; on the contrary, he believed constructive history was the most authentic history they possessed. It was well known that circumstances could not lie, and it was from circumstances that constructive history was built up. Dr. Leitner said there was something greater than the sympathy of one's fellow countrymen, and that was truth:—*Magna est veritas, et prævalebit*, and with that he quite agreed; but it would be found that the sympathy to which he referred was sympathy founded on truth—on a true view of Indian history.

Miscellaneous.

THE FORESTS OF TASMANIA.

Tasmania is peculiarly a forest country, and it is stated in the "Tasmanian Official Record," a publication recently issued by the Government Statistician and Registrar-General of Tasmania, that trees of great dimensions tower over and eclipse all the lesser undergrowths on plains, valleys, hills, and mountain slopes. Of the 16,778,000 acres comprising the total area, there are only 75,000 acres occupied by lakes, and 488,354 acres of cultivated land only partially cleared of its timber. With the exception of minor areas on the tops of mountains or among the barren uplands of the western highlands, the whole of the rest of the country is occupied with an almost continuous virgin forest, mainly composed of the various forms of *Eucalypti* (gum trees), one noted example of which the *Iolosa Blue Gum*, has been recorded as measuring 330 feet high. Many of these trees have stems measuring 150 feet high without a branch, with a girth of about 40 feet towards the base; and it is also recorded that a blue gum at Southport (*Eucalyptus globulus*), the prevailing tree towards the south of the island, "contained as much timber as would fully suffice to build a 90 ton schooner." With such a wealth of forest trees, Tasmania's sources of timber supply must be infinitely great, and in the near future must be of great industrial value; but the difficulties of transit, the ignorance of their economic value in distant markets, the plethora of local supply, and the necessity for clearing the land in the most convenient way, all tend, it is said, to produce waste and improvidence in respect of timber products, which might soon become a great source of national wealth. The necessity for the better conservation of the natural forests in Tasmania has lately commanded the attention of the local government, and a department has been created for the purpose of establishing conserved areas, and for regulating all matters connected with the cutting of timber on Crown lands. The following is a description of the more important timbers as regards their industrial value. The "blue gum" has its home principally in the southern parts of Tasmania, where it attains great dimensions. Many of these trees exceed a height of 280 feet, with a girth of from 40 to 50 feet. A tree called "Lady Franklin's Tree," near Hobart, is stated to have a circumference of a 107 feet at a height of 4 feet from the ground. The timber of the blue gum is of rather a pale colour, hard, heavy, strong and durable. In transverse strain its strength is about equal to English oak. It is used in house and ship-building, and also by carriage builders and manufacturers of tools. The "peppermint tree" has a wide range, as it is found in the southern and eastern humid districts of Victoria and

New South Wales, as well as in Tasmania. It varies greatly with altitude, climate, and soil, and is found at all heights up to 4,000 feet elevation. In the poorer lands the trees, though tall, are not remarkably so, but in the deep wooded gullies and in the moist ravines of mountains it attains such remarkable dimensions that it has obtained the distinction of the "giant eucalypt" of Australia. The timber of this tree is useful for many kinds of carpenters' work; in drying it does not split. It is also used in ship-building for keelsons and planking. Besides its timber this tree is famous for other products of value. The ashes of the foliage yield, it is stated, 10 per cent. pearlsh, and from 1,000 lbs. of fresh leaves, with their small stalks and branches, the yield of eucalyptus oil by far surpasses all that of other congeners, amounting to as much as 500 oz. per 1,000 lbs. The "stringy bark gum" is a valuable tree, found in abundance in Victoria, South Australia, and Tasmania. It is straight stemmed and of rapid growth, attaining a maximum height of 300 feet. The wood of this tree supplies a large portion of the ordinary sawn hard timber for rough building purposes. It is also well adapted for carriage, cart, and waggon-building, wheelwork, and agricultural machinery, as well as for the framing of railway carriages and trucks. The "white gum," or "Manna tree," is abundantly distributed throughout the island, and has also a wide distribution on the mainland of Australia. Its timber is used for shingles, rails, and for rough building materials. The small branching trees on open ridges and plains are noted for exuding a sugary substance called "manna," which is esteemed a great luxury, and eagerly sought for by the young. The "gum-topped stringy bark" is held in high esteem in Tasmania, and the chief peculiarity of this tree is, that while the lower part of the butt is clothed with a thick fibrous bark, closely resembling that of the common stringy bark, the upper part and the smaller limbs and branches are quite smooth. The timber from this tree is highly prized, and it is described by many competent authorities as second only to the "blue gum." The "iron bark" is a valuable tree attaining a height of 150 feet. The trunk is sawn into good timber, and it is also used for posts and rails. The "red gum," "cider gum," and "weeping gum" trees are also of some importance. One of the most handsome of the native trees is the "blackwood," which is widely distributed along the slopes of the north-west coast. It attains a height of from 60 feet to 130 feet. The timber is of a brownish colour, closely striped with streaks of various shades of a reddish brown. The more ornamental logs of this wood are exceedingly beautiful, and fetch a high price. The myrtle or beech is common in Tasmania, and forms a large proportion of the forests. The "huon" pine is said to be the grandest and most useful of all the soft woods. It is abundant along the rivers of the south-western parts of the island, attaining a height of from 60 to 120 feet,

with a diameter from 3 to 8 feet. Its timber is almost indestructible in any situation. It is largely employed, locally, for all kinds of furniture and ornamental work, and is the most highly-esteemed of all kinds of wood for the lighter sea craft. Among the other trees of Tasmania may be mentioned the "red pine," "oyster bay pine," "silver wattle," "black wattle," "native cherry," &c. The value of Tasmanian bark and timber exported during the last five years amounted to £627,361, or an average of about £125,472 a year. This represents nearly one-eleventh of the total exports.

WILLOW-WARE MANUFACTURE IN GERMANY.

The American Vice-Consul at Sonneberg, in his last report, says that Thuringia and Bavaria are the places in Germany in which the willow-ware industry has its principal seat. In Thuringia, Coburg is the centre; in Bavaria, Lichtenfels. Both places belong to the district of Sonneberg, from which the products of this industry are exported, finding a ready sale all over Germany, Austria, Switzerland, France, Italy, Spain, Portugal, Belgium, Holland, England, and the United States. The principal raw material for the product of this manufacture is the willow, found in all moderate climes, and whose culture nature provides for without needing any particular care. Besides the willow, an important raw material is the Indian, or so-called Spanish reed, imported from India by way of Hamburg and the Netherlands ports, chiefly coming as ballast. The reed is washed and bleached after being assorted; it is then peeled, split, and the kernel, called *bottichrohr*, is thrown out. Palm leaf and esparto are also used; the former being imported from Cuba, is chiefly used to manufacture baskets and trunks for travelling purposes. Another esparto, a flax-like straw, comes from Spain. Of less importance are some other materials, a kind of esparto made of thin wood fibres in Bohemia, China mats, straw braids from Italy and the Black Forest, hemp, leather trimmings, and other articles. The most important raw material for the basket maker remains, however, the willow, whose pliant twigs are adapted for not only the coarsest articles, but after being split, bleached, or coloured, are used to produce the most choice and delicate articles of braiding work. The willow or osier, which grows on the banks of the Main and its affluents, the Rodach, Steinach, and Kronach, on a sandy gravel and moist ground, not furnishing sufficient material for the manufacturers, it has been found necessary to have recourse to France, Belgium, and other countries for supplies of the raw material. More attention has lately been devoted to the culture of the willow in Germany. Since the year 1870, farmers have learned to drain the ground, and choose the proper locality for the culture of the

willow; but, notwithstanding the advantages resulting from this improved culture, very little progress has been made, and, consequently, the importation of foreign willows is still very considerable. Among the articles manufactured may be enumerated the following:—Baskets of all kinds and sizes, for washing, packing, carrying, and travelling purposes; for ladies' work, for flowers, sweetmeats, &c.; work-tables, newspaper and music stands, baby and doll carriages, stools, chairs, tables, and many fancy articles are produced; and these all find a ready sale in Lichtenfels and Coburg. There are no manufacturing, properly so called, except one or two, where the work of braiding is done, as the manufacture is essentially a home industry. The whole family is engaged upon it; and, once or twice a week, they carry the finished article to the exporting houses in Lichtenfels and Coburg, receiving cash for them, and carrying home, in most instances, the raw material which they need to renew their work. The estimated annual value of the basket-ware exported from Lichtenfels and Coburg is about £200,000.

Correspondence.

TUSSUR.

It may be noticed as to the valuable monograph of Mr. Thomas Wardle, that the subject of tussur was first brought before the Indian Section, and strongly urged by the late Dr. Archibald Campbell, Superintendent of Darjeeling. Mr. Wardle has, by his long and successful labour given practical realisation to these hopes, and created an important branch of industry.

In reference to his last observations on that interesting population of the Santhals, it may be mentioned that the language of one of the tribes is almost identical with one of those of Central Africa, as illustrated by me in a paper read before the Royal Asiatic Society, but not published.

HYDE CLARKE.

General Notes.

ELEPHANT LEATHER.—The *Board of Trade Journal*, quoting from the *Boston Journal of Commerce*, says that the tanning of elephant hides is comparatively a new industry. The method employed is practically the same as in the tanning of cow hide, except that a stronger combination of the tannic ingredients is required, and greater length of time—about six months—is necessary to perform the work. When the hide is taken out of the vat it is $1\frac{1}{2}$ inches thick. Articles made of elephant hides are expen-

sive luxuries. A small pocket-book of elephant's leather, without any silver or gold ornamentation, costs about £8. A small satchel made of the same leather costs from £60 to £80. Cigar cases, card cases, and similar articles vary from £5 to £20. Floor rugs are also made out of the leather. In finishing the hide no attempt is made to glaze or polish it. Everything is done to preserve its natural colour and appearance. It is a very enduring leather, several years' wear having but little effect on it."

CONSTANTINOPLE COMMERCIAL MUSEUM.—The Ottoman Commercial Museum has recently been established at Constantinople, in which samples of native and foreign products are classified under the following heads:—1. Textile fabrics. 2. Native and foreign manufactures of special kind. 3. Products of the soil. 4. Eatable sand liquors. 5. Millinery and haberdashery. 6. Mineral and metallic substances. 7. Timber, wood-work, furniture. 8. Stones, moulds, pottery, glass ware. 9. Skins, raw or wrought. 10. Chemicals and the preparations derived therefrom. 11. Mercery articles; musical instruments. 12. Paper and its appliances.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 22...British Architects, 9, Conduit-street, W., 8 p.m. J. Tavenor Perry, "Mediæval Architecture in Sweden."

TUESDAY, JUNE 23...Statistical, School of Mines, Jermyn-street, S.W., 5 p.m. Annual Meeting.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Discussion on "Orthochromatic Photography."

Anthropological, 3, Hanover-square, W. 8½ p.m. 1. Mr. H. Balfour, M.A., Exhibition of Tasmanian Stone Implements. 2. Dr. Joseph Prestwich, "The Primitive Character of the Flint Implements of the Chalk Plateau of Kent, with Reference to the Question of their Glacial or Pre-Glacial Age;" with Notes by Messrs. B. Harrison and De Barri Crawshaw.

WEDNESDAY, JUNE 24 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting. Geological, Burlington-house, W., 8 p.m.

Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

THURSDAY, JUNE 25...Chemical, Burlington-house, W., 8 p.m. Extraordinary General Meeting.

FRIDAY, JUNE 26...United Service Institution, Whitehall-yard, S.W., 3 p.m. Lieut.-General Sir W. F. Drummond Jervois, "The Supremacy of the Navy for Imperial Defence."

Royal Institution, Albemarle-street, W., 9 p.m. Faraday Commemoration Lecture, by Professor Dewar.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Professor W. E. Ayrton and Mr. T. Mather, "The Construction of Non-Inductive Resistances." 2. Mr. C. A. Carus-Wilson, "The Influence of Surface-Loading on the Flexure of Beams." 3. Mr. C. V. Boys, "Pocket Electrometers." 4. Mr. J. Enright, "Electrification due to the Contact of Gases with Liquids."

SATURDAY, JUNE 27...Botanic, Inner Circle, Regent's-park, N.W., 3½ p.m.

Journal of the Society of Arts.

No. 2,014. VOL. XXXIX.

FRIDAY, JUNE 26, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the report from the Council, and the Treasurers' Statements of Receipts, Payments, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 24th instant, at four p.m., Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, in the chair.

The SECRETARY read the notice convening the meeting, and the minutes of the previous annual general meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society:—

Agnew, William, 113, Cannon-street, E.C.
 Anderson, Andrew Whitford, 46, Warwick-gardens, Kensington, W.
 Andrews, Charles Davis, The Square, Leominster.
 Arnold, George Matthews, J.P., Milton-hall, Gravesend, Kent.
 Butcher, William, Fraser-house, South Shore, Blackpool.
 Cohen, Miss, 13, Broadhurst-gardens, N.W.
 Collier, R. W., 30, Lincoln's-inn-fields, W.C.
 Corrie, David, Nobel's Explosives Company Limited, Polmont Station, N.B.
 De Neufville, Richard, The Brooms, Crystal Palace Park-road, Sydenham, S.E.
 Ely (Lord Alwyne Compton), Bishop of, Ely-house, 37, Dover-street, W.
 Evans, Dr. P. Norman, F.C.S., 28, Great Ormond-street, W.C.
 Furnivall, Willoughby Charles, 29, Devonshire-place, Portland-place, W.
 Gage, Franklin Howard, 12, Tokenhouse-yard, E.C.
 Goodacre, Robert Johnson, J.P., Regent-road, Southfields, Leicester

Goodyer, F. B., 155, New Bond-street, W.
 Greenhough, David W., 5, Rood-lane, E.C.
 Habershon, A. Eustace, 27, Chancery-lane, W.C.
 Hardman, Josiah, Milton, near Stoke-on-Trent.
 Hasted, Colonel John Ord, 1, Dynevor-road, Bedford.
 Hemmerde, George Richard, 1, St. James's-square, S.W.
 Hibbert, E. J., Ays-garth, Tunbridge Wells, and Baramulla, Kashmir.
 Hicks, James, Redruth.
 Jackson, Clement Weyland, 20, Clifton-terrace, Brighton.
 Laurie, A. P., King's College, Cambridge.
 Molesworth, Sir Guilford L., K.C.I.E., The Manor-house, Bexley, Kent.
 Moore, William Bailey, Cauldon-house, Shelton, Stoke-on-Trent.
 Ogilvie, Campbell P., Sizewell-house, Leiston, Suffolk.
 Ogle, William, Rodwold, Chislehurst, Kent, and 90, Cannon-street, E.C.
 Ord, William Miller, M.D., F.R.C.P., 37, Upper Brook-street, W.
 Robinson, George Thomas, 20, Earl's-terrace, Kensington, W.
 Rosse, Earl of, K.P., F.R.S., Athenæum Club, S.W.
 Savery, Charles E., 29, Denbigh-street, S.W.
 Selby, Prideaux, 4, Threadneedle-street, E.C.
 Skeggs, J. B., Town-hall, Poplar, E.
 Slater, John, 46, Berners-street, W.
 Stevens, James, Lime Tree-house, Macclesfield, and 88, Mosley-street, Manchester.
 Stott, Nowell Stanhope, Fairview, Chislehurst, Kent.
 Stuart, Herbert Akroyd, Bletchley, Bucks.
 Sumner, William, Mus.B., Selley-lodge, Wimbledon, Surrey.
 Tunstall, Wilmot, Brook's House, Meltham Mills, near Huddersfield.
 Tupper, Charles L., 77, Gloucester-terrace, Hyde-park, W.
 Vicars, John, 8, St. Alban's-square, Bootle.
 Wadia, Hon. Navroji Nusservanji, C.I.E., Bombay.
 Walker, Lieut.-Colonel Edward Robinson, Barnfield, Oxford-road, Manchester.
 Wallace, Alexander Falconer, 9, Sussex-square, W.
 Ward, Thomas, Brookfield-house, Northwich.
 Waterlow, George Sydney, Chalet Evers, Biarritz, France.
 Webber, Samuel Blatchford, 54, London-road, Bromley, Kent.
 Welman, Samuel, Oakdene, Godalming, Surrey.
 Willcox, Benjamin, 47, Lincoln-inn-fields, W.C.
 Wilson, Robert Henry, 202, Cromwell-road, S.W.

The CHAIRMAN nominated Mr. W. Martin Wood and Mr. Wyatt Papworth scrutineers, and declared the ballot open

The SECRETARY then read the following—

ANNUAL REPORT.

I.—ORDINARY MEETINGS.

In the address with which the Chairman of Council, Sir Richard Webster, opened the Society's Session in November last, he dwelt specially upon the functions of the Society of Arts in relation to inventions, and the work which the Society had done in that connection. Taking a number of selected subjects, the Chairman traced the effect which the labours of the Society of Arts in past years had had upon the progress of invention in each class, and showed what important practical results had sprung from its action. At the first Ordinary Meeting after the one at which the Chairman's address was delivered, Mr. Francis Galton brought forward a subject which has been much before the public in recent years—that of "Physical Tests in Competitive Examinations." The advantage of combining physical with intellectual tests at such competitions has been generally admitted; but it has always been felt to be impossible to compare the results of athletic competitions with those of examinations in intellectual subjects. Mr. Galton proposes to do away with the difficulty by substituting for anything of the nature of an athletic competition anthropological measurements, and he has collected a good deal of evidence to show that such measurements may, to a large extent, be relied upon as a test of physical capacity.

At the following meeting Mr. Dredge, who had just returned from Chicago, gave an account of the arrangements, so far as they had then gone, for the great Exhibition which it is proposed to hold in that city in 1893. Since that date, as the Members are aware, the conditions laid down by the Government of the United States having been complied with, that Government has adopted the Exhibition, and has issued a formal invitation to foreign countries to take part in it. The invitation addressed to England has been accepted; but the intentions of the Government, as to the arrangements necessary for enabling a British Section to be formed, have not yet been made known. It is, however, understood that some announcement will be made before the conclusion of the present Session of Parliament.

The next paper read was one in which Mr. Bailey, the engineer of the Metropolitan Electric Supply Company, gave an account of the

present condition of electric lighting in London. Mr. Bailey's paper has a permanent value, as showing in considerable detail the actual state of electric lighting in London at the time when it was read.

At the last meeting before Christmas Mr. George Davison, who is well known as an amateur photographic artist, read a paper on "Impressionism in Photography," and stated very clearly the views which are held by the special school of photographers who have done most of late years to advance the claims of photography to be considered as an art.

In the first paper after Christmas Mr. J. F. Green gave an account of the Steam Lifeboat which has been constructed by his firm, the first successful instance of the application of steam, or indeed of any motive power, to the purpose. From the account given by Mr. Green, it may be taken as proved that, in certain situations, especially where the boat can start from a harbour, a steam lifeboat can be most usefully employed; and it is to be hoped that, wherever the necessary facilities exist, such boats—notwithstanding the increased cost—will be put on the service.

Under the title of "Photography in Aniline Colours," Messrs. Green, Cross, and Bevan gave an account of what is certainly the newest application of photography. These chemists have discovered that a certain colouring matter, known as *primuline*, is affected by light in such a way that after exposure it will not combine with certain other colouring matters, the result being that if a fabric be dyed with *primuline*, and then exposed under a transparency, the part exposed will, when the fabric is afterwards suitably treated, remain unaffected, while the parts unexposed can be made to take any one of a great number of colours. It is evident that there is here a possibility of the application of photography on an industrial scale to the dyeing and printing of fabrics.

Later on in the Session, Professor Hummel dealt with a subject of a kindred nature, for under the title of "Fast and Fugitive Dyes," he gave the results of the very elaborate series of experiments he has recently been conducting, to show how far the dyeing materials in common use, both the coal-tar colours and the older vegetable colours, are affected by light. Professor Hummel seems to have given something like absolute proof that there is no reason for the belief that the aniline colours are more fugitive than most of their predecessors, and certainly he showed that

artificial madders and similar colouring matters are neither more nor less permanent than like colours of vegetable origin. A paper dealing with a somewhat similar subject was that by Mr. Laurie, on "The Durability of Pictures painted with Oils and Varnishes," though on this occasion it was not the question of the permanence of dyes, but of that of the lasting of the ordinary artists' pigments when used under the conditions which prevail in oil-painting.

Two papers during the Session dealt with subjects relating to currency—Mr. Dowson's on "Decimal Coinage, Weights, and Measures," and Sir Guilford Molesworth's on "Bimetallism." Both gave rise to considerable discussion.

As papers dealing with questions of civil engineering may be classed together, one read by Sir Roper Lethbridge on the proposed "Irish Channel Tunnel," and one by Mr. Cheesewright on "Harbours: Natural and Artificial." Sir Roper Lethbridge made very evident the advantages that would arise from a tunnel, and showed the different schemes which had been proposed to carry it out, but neither the paper nor the discussion which followed held out any very great probability of the scheme being put into practical execution, at all events for some time to come.

Sir Charles Wilson's paper on "The Ordnance Survey" may perhaps be placed in the same class with the two last mentioned. The value of the work done by the Survey is not sufficiently appreciated by the general public; and a paper of the sort is useful, as drawing public attention to it.

Turning to subjects of mechanical engineering, Mr. Harrison Carter read a very full and elaborate paper on "Modern Flour Milling," a subject of great importance, and in which there have been great mechanical advances in recent years. Professor William Robinson added a good deal to the information which has been published, in his paper on the "Use of Petroleum in Prime Motors," carrying on very usefully the discussion of the subject, which was dealt with in Mr. Graham Harris's Cantor Lectures in the year 1889. The question of the "Sources of Petroleum" naturally must be taken with that of its uses, and this was brought before the Society by Mr. William Topley. In this case also the paper formed a useful appendix to a course of Cantor Lectures, namely, that by Mr. Redwood.

Mr. Carmichael Thomas in his paper on "Illustrated Journalism," brought before the

Society in the most graphic and interesting manner the very great progress which has recently been made in the illustration of weekly and daily newspapers. For many years this subject has been before the Society of Arts, and a reference to back numbers of the *Journal* will show frequent anticipation of the point which has now been reached in the rapid publication of illustrations.

In his paper on "Colonisation and its Limitations," Mr. Ravenstein carried on a little further the discussion of a subject which attracted much attention when he first brought it before the British Association in September last—the question of the extent of ground upon the earth probably available for purposes of colonisation.

Mr. Newman Lawrence and Dr. Harries, in a very careful and suggestive paper, discussed the effect of electricity on the human body, both as regards the dangers from electric lighting and as regards possible applications of electricity to curative purposes. The latter part of the subject has been so much left to quacks and vendors of nostrums that it requires some courage on the part of a medical man to deal with it, and that this should be so is most distinctly a matter for regret. It would probably be to the advantage of both sciences if physicians of experience would ally themselves with duly qualified electricians in the discussion of this difficult but important subject.

Mr. Fleming's paper on "The Sources and Applications of Borax" contained a great deal of information which is probably not available elsewhere. It is doubtful whether before it was read many persons knew how numerous and varied are the applications of this useful mineral.

II.—INDIAN SECTION.

The Session began on the 22nd of January, with a practical paper, by M. E. J. Watherston on "The Hall-marking of Silver Plate, with special reference to India." Mr. Watherston argued in favour of optional Hall-marking in the United Kingdom, and, with regard to India, he suggested the employment of the "touch" instead of the "scrape and parting assay." The proposal to establish in that country a system of Hall-marking for exported plate was described as "altogether impracticable." The discussion disclosed a diversity of opinion on this point. In the interests of the Indian silversmith, Sir George Birdwood was strongly in favour of compulsion for wares

shipped to Europe, while other speakers, including Mr. T. H. Thornton, Sir Charles Bernard, and the Chairman (Sir T. C. Hope), agreed with Mr. Watherston's views. A letter was received from Sir Thomas Farrer, stating that he was "more satisfied than ever that the true remedy for the anomalies and difficulties of the present law is to abolish compulsory Hall-marking altogether." Mr. Watherston's services in the movement that led to the withdrawal of the plate duties were fully recognised. At the second meeting, 27th of February, Mr. Robert Gordon, M.Inst. C.E., and formerly of the Public Works Department in Burma, read an excellent paper on "The Economic Development of Siam." Mr. Gordon, who had just returned from Bangkok, where he filled for some time an important official position, predicted a prosperous future for Siam. Interesting speeches were made by Sir Hugh Low and other gentlemen connected with the Malay Peninsula, the value of Mr. Gordon's information and the soundness of his views being unanimously admitted. The Chairman (Sir C. E. Bernard), who, as an ex-Chief Commissioner of Burma, is thoroughly acquainted with Siamese affairs, went so far as to express the opinion that within the next half century Siam "might become a great and important country." The interest taken in this paper was shown by the presence of the Chargé d'Affaires and other members of the Siamese Legation in London. "Indian Village Communities, with special reference to their Modern Study" was the subject of a paper of great interest to settlement officers and students of ancient institutions, read at the third meeting, 9th of April, by a well-known authority on Indian land systems, Mr. B. H. Baden-Powell, C.I.E. Reference was made by Mr. Baden-Powell to the urgent need of better statistics, and the hope was expressed that this might be remedied by the influence of the Society of Arts, "so often exercised for good." In the discussion the appointment of a special officer to examine the village records in different parts of India with the view to the production of a comprehensive work on the subject was suggested. The desirability of the required information being "arranged statistically on ethnographic and other points" was also insisted upon. The chairman on this occasion was the ex-Lieutenant-Governor of Bengal, Sir Steuart Colvin Bayley. On the 30th of April, Colonel J. O. Hasted, R.E., formerly Public Works Secretary to the Government of Madras, described the irri-

gation project now being carried out in the Periar Valley at an estimated cost of £542,500. The work was commenced in 1887 and is to be completed in 1895. The utility of the scheme thus brought to the notice of the British public for the first time was affirmed by among others Sir Theodore Hope, late Public Works Member of Council in India. That distinguished authority on Indian irrigation, Sir Arthur Cotton, who unfortunately was prevented by his age and deafness from being present, has, in a letter to the Society's *Journal*, since recorded his approval of the Periar project, which as the Chairman (Sir Mountstuart Grant-Duff) observed, has been a pet of the Madras Government from generation to generation. On the 14th of May, Mr. Thomas Wardle gave an admirable account of the extended uses to which Tussur silk is now being put in European textile manufactories. Many beautiful specimens of silk stuffs were exhibited in the room, and added very much to the attractiveness of a most successful meeting. Another of its features should be mentioned. The presidential chair was occupied by the Lady Egerton of Tatton, who is distinguished for her efforts to encourage the English silk industry. This is the first time that a lady has presided on such an occasion. At the closing meeting, on the 30th of May, Mr. C. L. Tupper, B.C.S., Chief Secretary to the Punjab Government, read an able and suggestive paper on "The Study of Indian History." The object was to demonstrate the value of the study of Indian history, and to show that study might be made easier, as well as more profitable. *Inter alia*, Mr. Tupper recommended that Government should undertake the preparation and publication of a good biographical dictionary of India. He also pointed out the want of a first-class historical atlas.

III.—FOREIGN AND COLONIAL SECTION.

The first meeting of this Section, which had been fixed for the 20th January, was unavoidably abandoned in consequence of the indisposition of Mr. William Wylde, C.M.G., who had undertaken to read a paper on the subject of "The Opening of Africa." It is hoped that Mr. Wylde will read this paper in the course of next Session. On February 17th, Commander V. Lovett Cameron, C.B., read a paper on "Chartered Companies in Africa," wherein the reader gave his views as to the policy which should guide the Government in

granting to commercial corporations sovereign rights over uncivilised races. On March 17th, Sir Edward Braddon, K.C.M.G., Agent-General for Tasmania, contributed a paper, in which he gave striking evidences of the industrial development that is taking place in that colony, and drew special attention to the value of its minerals. A valuable historical paper on the principal dynasties which have ruled in China, was read by Sir Thomas Wade, G.C.B., at the meeting on the 21st April. On May 5th, Captain Telfer, R.N., read a paper entitled, "Armenia and the Armenians," in which he described the past history and present position of that country, and advocated a scheme for its future independence. Interesting details were given of the customs and industries of the Armenians, and the paper was illustrated by views and by specimens of native handiwork. A paper communicated by Mr. C. S. Wilkinson, of the Geological Survey of New South Wales, on the mineral resources of that colony, was received too late to be read at the meeting on the 26th May, which had been set apart for its delivery. It will, however, be printed in an early number of the *Journal*.

IV.—APPLIED ART SECTION.

The meetings of the Section were commenced on January 27 with a paper entitled "Lithography: a Finished Chapter of Illustrative Art," by Mr. William Simpson, who gave an interesting account of the history of the art, and showed that, although lithography was largely practised, it was no longer used as a mode of illustrating books, as was formerly the case. Mr. Simpson, himself an accomplished lithographer, was able to speak with authority on this point. On February 10th, Mr. Heywood Sumner described the art of "Sgraffito" from the craftsman's point of view, and illustrated his paper by a demonstration of the process adopted. Mr. Sumner claimed that the process was not mechanical, but that the outcome was the artist's own direct work. Mr. Starkie Gardner treated of "Enamels and Enamelling" on March 10; and in tracing the history of this beautiful art, pointed to the early use of enamelling on bronze in Britain. The result of his researches incline him to believe that many of the old enamels, about the history of which little is known, but which are classed under the general heading of "Byzantine," were really of British or Anglo-Saxon origin. Mr. Clement Heaton's paper on "The Use of *Cloisonné* for Decoration in Ancient and Modern Times"

was, to some extent, a complement to that of Mr. Starkie Gardner; but the writer treated *cloisonné* as a process of much wider adoption than any system of enamelling, and his object was to trace *cloisonné* (or the use of *cloisons* as cells in which colour is held, thus forming neutral lines between various colours), both in architecture and decoration, among the oldest artistic nations. The next paper, read on April 14, was by Mr. G. T. Robinson on "Decorative Plaster Work." The writer dealt with modelled stucco work, and gave a most interesting account of its early use in Italy, and its introduction into France and England. He strongly advocated the revival of the art which allowed of the direct work of the artist, and should supersede the use of moulded work now so common. This is a subject about the history of which little has been written, and it is one which Mr. Robinson has made peculiarly his own. The last paper of the Session was on "Glass Painting," read by Mr. H. Arthur Kennedy, on May 12. It contained a valuable statement of the distinctive characteristics of the art, and a warning against the constant neglect of the true principles of painting on glass as distinct from those of painting on an opaque medium. The Society is greatly indebted to the Science and Art Department for the manner in which the resources of the South Kensington Museum were placed at its disposal for the illustration of the papers of Messrs. Sumner, Gardner, Heaton and Robinson.

V.—CANTOR LECTURES.

Five courses of Cantor Lectures were given this Session. The first of these was a course of five lectures by Professor Vivian Lewes, on "Gaseous Illuminants." The subject is one which has previously been dealt with before the Society by Professor Vernon Harcourt in 1877, and in various papers. Prof. Lewes dealt with the more recent improvements which have been introduced into the manufacture of gas, especially the use of water-gas, and also went to a considerable extent into the proper conditions under which gas is best used as an illuminant, and as a fuel.

Mr. Hipkins is well known as the greatest authority in this country on the history of the pianoforte, and the three lectures which he gave on "The Construction and Capabilities of Musical Instruments" attracted large and interested audiences. A special feature of these lectures was the performance by Mr.

Hipkins himself upon the harpsichord and the spinet, and by Mr. Dolmetsch and his assistants on various old stringed instruments.

The third course was by Mr. Gisbert Kapp, on the "Electrical Transmission of Power," a subject the earlier development of which has been treated in previous papers and lectures before the Society of Arts. Mr. Kapp's lectures brought it down to the most recent date, and formed a valuable addition to the literature of the subject.

In spite of the great number of persons who now devote themselves to the practice of photography, either as a profession or an amusement, the scientific side of the question usually receives less attention than might have been expected; and Professor Meldola's course of lectures on "Photographic Chemistry" formed a useful continuation of the valuable lectures which have been given in the Society's Rooms in previous years, by Capt. Abney, Mr. Bolas, and others.

In the last course of lectures, Mr. Hugh Stannus dealt with a subject of considerable importance to decorative artists, the "Decorative Treatment of Natural Foliage," which he treated in a thoroughly practical manner, by showing how the foliage should be trained to fill its appointed place, and how the plants should be selected for the special purposes required. The lectures were highly appreciated by the audience (which largely consisted of students), not only on account of the value of the teaching, but also for the spirit and humour with which that teaching was illustrated.

VI.—JUVENILE LECTURES.

In selecting subjects for the Christmas Juvenile Lectures, the Council have never felt themselves to be confined to subjects coming strictly within the province of the Society, such as might fitly form the material of Cantor Lectures, but have deemed themselves at liberty to adopt any scientific subject likely to be of interest and value to the audience, for whose special benefit the lectures are intended. For the present Session they asked Mr. E. B. Poulton to bring before the Society some of the results of the special study to which he has devoted himself, that of "Mimicry in Animals." The two lectures which Mr. Poulton delivered were of the most interesting and attractive character, their special feature being the large extent to which they were illustrated by a great number of coloured figures of animals and their environment,

showing how many animals imitated one another and surrounding objects, and the purpose of the mimicry.

VII.—POPULAR LECTURES.

In previous Sessions, the Council have found that courses of lectures on scientific subjects of a popular character have been well appreciated by the members, and they felt sure that, in inviting Captain Abney to deliver four lectures on the Science of Colour, they were adopting a course which would meet with the approval of the Society generally. While treating the subject in an elementary manner, Captain Abney yet introduced a great deal of the most recent information, and, indeed, brought before the Society the result of investigations which had hardly been made public before. This was the first occasion, after the meeting of the Royal Society, at which the apparatus was described, when the system devised by Captain Abney for the accurate measurement of colour was brought before the public. As he informed the members, Captain Abney is now able not only to match any conceivable tint by the spectrum colours, but to match it by a mixture of a single spectrum colour (the position of which, in the spectrum, can of course be accurately registered), with an amount of white light which can be measured with precision. By these means, therefore, any tint whatever can be expressed by a definite formula, which enables it to be produced as a patch of coloured light on the screen of the apparatus at any time.

VIII.—ALBERT MEDAL.

The Albert Medal for the present year has been awarded by the Council, with the approval and sanction of the President, to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

Sir Frederick Abel is well known to Members of the Society, having served a term of office as Chairman of the Council, and having been, for many years past, a member of the Council itself, though he was not a member of that body at the time the award was made.

position in chemical science in this country, both as regards the advance of the science itself, and with reference to very many of its industrial applications. His most important work has been done in connection with explosives, and, for this, he received the Royal Medal of the Royal Society in 1877. As a member of the Royal Commission on Accidents in Mines, he brought his special knowledge to bear on the causes of explosions in coal mines; and the important report published by that Commission owed much of its value to Sir Frederick Abel's share in it. Amongst other subjects with which his name is associated, may be mentioned the storage and use of petroleum, and the manufacture of iron and steel. Sir Frederick Abel is also distinguished as an electrician, having served as President of the Institution of Electrical Engineers, as well as of the three chemical societies, the British Association, and the Iron and Steel Institute.

IX.—MEDALS FOR PAPERS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1890-91:—

At the Ordinary Meetings:—

To J. F. GREEN, for his paper on "Steam Life-boats."

To A. G. GREEN, C. F. CROSS, and E. J. BEVAN, for their paper on "Photography in Aniline Colours."

To CARMICHAEL THOMAS, for his paper on "Illustrated Journalism."

To Colonel Sir CHARLES WILSON, K.C.B., K.C.M.G., F.R.S., for his paper on "Methods and Processes of the Ordnance Survey."

To A. P. LAURIE, for his paper on "The Durability of Pictures painted with Oils and Varnishes."

To Prof. WILLIAM ROBINSON, for his paper on "The Use of Petroleum in Prime Motors."

To Prof. J. J. HUMMEL, for his paper on "Fast and Fugitive Dyes."

In the Indian Section:—

To B. H. BADEN-POWELL, C.I.E., for his paper on "The Indian Village Communities, with Special Reference to Modern Investigation."

To THOMAS WARDLE, for his paper on "The Use of Tussur in European Textile Manufactures."

To CHARLES L. TUPPER, B.A., for his paper on "The Study of Indian History."

In the Foreign and Colonial Section:—

To Sir EDWARD N. C. BRADDON, K.C.M.G., for his paper on "Recent Development of Tasmanian Industries."

To Sir THOMAS WADE, G.C.M.G., K.C.B., for his paper on "China."

In the Applied Art Section:—

To WILLIAM SIMPSON, for his paper on "Lithography: a Finished Chapter of Illustrative Art."

To G. T. ROBINSON, F.S.A., for his paper on "Decorative Plaster Work: Modelled Stucco Work."

Thanks were voted Mr. JAMES DREDGE for his paper on "The Chicago Exhibition." Mr. Dredge being a Member of Council, and therefore, under the usual practice of the Council in such cases, not eligible for the award of a medal.

X.—MULREADY PRIZES.

The Council of the Society are trustees of a sum of £109, the balance of an amount collected in 1875 for a memorial to Mulready, the interest of which is to be applied, after keeping the monument to Mulready at Kensal-green in repair, to giving occasionally a Mulready Medal to students of Schools of Art in the United Kingdom, for drawings from the nude. The Council are now offering two Gold Medals, or two Prizes of £20 each, for competition among the students in 1892 and 1893, one in each year, for drawings from the nude.

The Science and Art Department have consented to assist the Society by allowing the adjudication to be made by their Examiners.

XI.—STOCK PRIZE.

In 1781 a sum of £100 was left to the Society by John Stock, to be invested in the public funds, and the interest applied for the promotion of Sculpture, Drawing, and Architecture. Various prizes have, from time to time, been awarded under this trust; and the Council now propose to offer a Gold Medal, or a prize of £20, to the student of a School of Art who shall send in at the competition of 1892 the best original design for architectural decoration, by means of wall-painting, stucco, carving, mosaic, or any other method.

As in the case of the Mulready Prize, the adjudication will be made by the examiners of the Science and Art Department.

XII.—OWEN JONES PRIZES.

These prizes have been awarded annually, since 1879, on the results of the annual competition of the Science and Art Department, to students of the Schools of Art who produce the best designs for household furniture, &c., on the principles laid down by Owen Jones. As usual, six prizes were offered last year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze He has for many years taken a very leading

Medal. A list of the successful candidates has appeared in the *Journal*.* A similar number of prizes has been offered for the present year (1891), and the result of the competition will be published in the *Journal* as soon as it is received from the Science and Art Department.

XIII.—BENJAMIN SHAW PRIZE.

In 1876 Mr. Benjamin Shaw, a member of the Society, left the sum of £133 to the Society, with the object of providing a £20 prize every five years for Industrial Hygiene. The prize was to be offered for any discovery, invention, or newly-devised method for obviating, or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means. On the last occasion of its being offered the prize was not awarded, and the Council are now consequently in a position to offer two prizes, each of the value of £20, under this trust. Having regard to the fact that the International Congress of Hygiene is to be held in London this autumn, the Council considered that the offer of prizes could most usefully be made through its agency, and they have consequently offered two Gold Medals or two prizes of £20 each for inventions or discoveries coming within the terms of the trust, and exhibited at or submitted to the Congress. The Executive Committee of the Congress have accepted the duty of assisting the Council in the award, and it is hoped that the offer may have the effect of bringing forward into public notice some invention of the character which it was the testator's object to encourage.

XIV.—FOTHERGILL PRIZE.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of prizes for the promotion of useful arts. Certain objects were proposed to the Society for consideration, and these all related to the prevention of fire. In making awards under this trust in former years, the Council have generally had in view the original suggestions of the testator, and, pursuing the same course, they now offer the Society's Gold Medal, or a prize of Twenty Pounds, for the best invention, having for its object the prevention or extinction of fires in theatres or other places of public amusement. Descriptions of inventions

to be submitted for the prize must be sent in before the end of the present year.

XV.—PRIZES FOR DRAWING.

It was stated in the last report of the Council that the Council had offered twelve Bronze Medals for drawings sent in by students to the exhibition held by the Drawing Society last year. The competition having in this, the first instance, proved successful, the offer was renewed for the present year, and twelve medals were again offered, and were awarded by the judges of the Drawing Society. The Council are assured that useful work is done by this Society in encouraging the study of drawing in middle-grade schools, and they have therefore acceded to the application of the Society to renew the offer for a third year.

XVI.—HOWARD LECTURES.

Mr. Thomas Howard, who died in 1872, bequeathed to the Society of Arts a sum of £500 for the purpose of presenting a prize to the author of a treatise on motive power. The prize having on several occasions been offered without any practical result of value, the Council considered that the most useful way of dealing with it would be to invite some eminent authority on the subject to deliver a course of lectures before the Society on a subject coming within the terms of the trust, on the understanding that the lectures should afterwards be published as a treatise on the subject. The result of this was, that Mr. Anderson delivered, in 1884-5, the valuable course of lectures, which were afterwards republished under the title of "The Conversion of Heat into Useful Work." Since that time the interest of the fund has accumulated to a sufficient extent to allow the Council to repeat their action, and they have accordingly invited Professor Unwin to deliver, during the next Session, a course of lectures on "The Generation of Power at Central Stations, and its Distribution therefrom." These lectures will afterwards be published, to form a treatise on the subject.

XVII.—EXAMINATIONS.

As announced in last year's report, Medals were offered to the best candidate in each subject; one Medal in each subject, an additional Medal in any subject for which 100 candidates presented themselves; and two additional Medals in any subject for which there were 500 candidates. In addition to these Medals, the liberality of

* See *Journal* September 5th, 1890, vol. xxxviii., p. 861.

certain of the City Companies—namely, the Clothworkers, Goldsmiths, Mercers, Skinners, and Salters—enabled the Council to offer prizes in the principal modern language subjects, including English, and also in Commercial Geography. Beyond the offer of Medals, no very great alteration was made in the programme for last year, except that the subject of Type-writing was added, an addition which has been fully justified by the number of candidates presenting themselves. The offer of Medals has certainly attracted a number of candidates of a higher class, because, while the total increase on the number of papers worked was 193—2,667 as against 2,474 in 1890—the number of First-class Certificates rose from 205 to 295, an addition of almost 50 per cent. The number of Second and Third-class Certificates were almost stationary—748 and 973 in 1891, against 747 and 975 in 1890. The number of failures also showed a considerable increase—651, as compared with 547 in the previous year. It is a little difficult to account for this increase, but, at all events, it may be taken as showing that the standard has not been lowered. The principal increase was in Book-keeping, always the most popular subject. For this there were 1,141 candidates (1,008 in 1890). No other subject shows a very large increase. The number of Shorthand candidates had grown from 554 to 608. In Italian, Spanish, and Portuguese the numbers all showed an increase. In Spanish there were 71 candidates, the attention directed to this important commercial language having, as far as the Society's Examinations are a test, steadily increased for some years back. The numbers in Italian and Portuguese are still low, only 13 and 12. It is satisfactory to note that at last the subject of Commercial Geography seems to be attracting attention, 46 candidates having entered for it. In Political Economy so few candidates have entered for some years back that the Council have come to the conclusion to omit it from the programme, and consequently this subject will not appear in the list for next year. Theory of Music still shows a decline, a matter perhaps not to be wondered at, now that other special institutions are coming forward to take up the work of examination in Elementary Music, a work which was long left to the Society of Arts. In the new subject of Type-writing, 99 papers were worked, but of these the examiner found it necessary to refuse certificates to no less than 60, and could only

find 4 deserving of a First-class. It is evident that, if the Society's Certificate is to have any value in a subject of this sort, it can only be if a high standard is adopted. Many of the candidates who entered this year showed a deficiency, not only in the mechanical manipulation of the apparatus, but also in general knowledge and intelligence, without which no person can hope to make a living as a type-writing clerk.

The programme for next year's Examinations will be issued very shortly. It is not proposed to make any important alterations in it. Medals and Prizes will be offered on the same terms as last year, and the subjects will be the same, with the exception, mentioned above, of Political Economy.

The School Board for London, being anxious to obtain some practical test for their teachers in the subjects of French, Book-keeping, and Shorthand, applied to the Council to know whether the Society would hold a Supplementary Examination in the autumn of the present year in those subjects, for School Board teachers. The Council, feeling that the request offered a gratifying testimony of the value of the examination, undertook to make arrangements for such an examination, provided that a sufficient number of candidates entered to justify such a course. The arrangements are now under consideration, and it is proposed that the examination should be held in September next, for London School Board teachers only, and at centres in or near London. The regulations will be precisely similar to those for the ordinary examinations of the Society.

XVIII.—PRACTICAL MUSIC EXAMINATIONS.

These examinations have been held, as usual, in London, during the present month. There were 276 candidates, some of whom were examined in more than one subject. Of these 256 passed the examination, taking 277 certificates. Five obtained full marks, and will consequently receive Bronze Medals. The total number of candidates is slightly less than last year, when there were 305. The proportion of First-classes is, however, larger—123, as compared with 111—and the proportion of Second-classes less—154, as compared with 175. That fewer candidates obtained Medals is accounted for by the fact that last year several who had already obtained First-class certificates came up, in the hope of obtaining a Medal, and succeeded in doing so. Four candidates went in for Honours, but none of

them succeeded in passing. The general average may be taken as, if anything, slightly better than in previous years.

XIX.—MEMORIAL TABLETS.

Since the announcement in last year's report* a memorial tablet has been placed on No. 19, Warwick-crescent, Paddington, in commemoration of the residence of Robert Browning in that house, from 1861 to 1887.

XX.—IMPERIAL INSTITUTE.

In May last, the Organising Committee of the Imperial Institute published the constitution of the Governing Body which it was the functions of that Committee to call into existence. The Governing Body, as now appointed, consists of Governors nominated by the Queen and the President (H.R.H. the Prince of Wales); *ex-officio* Governors (eight in number); Appointed Governors, representing the Colonies and India; Elected Governors, representing the United Kingdom; and representatives, for the time being, of Associations, of whom there are twenty-five. The Society of Arts is included in the list of Associations, and is to be represented by the Chairman of the Council, or by some other member of the Council to be elected for the purpose.

The Council have intimated their readiness to accept the duty of appointing a representative, and their desire that the office should be filled by their Chairman, the Attorney-General.

XXI. — INTERNATIONAL CONGRESS OF HYGIENE.

In response to a request from the Committee of the International Congress of Hygiene, which is to be held in August next, in London, under the presidency of H.R.H. the Prince of Wales, meetings of the Committee of the Indian Section and of the Foreign and Colonial Section were held to consider what action could be taken by the Society to secure the attendance of delegates from India and the Colonies at this Congress. On the recommendation of the Committees, communications were addressed by the Council to the Secretary of State for the Colonies and to the Secretary of State for India, urging upon them the importance of taking steps for securing the adequate representation of the Colonies and India at the Congress. The Council are glad to be able to state that their applications were effectual, and that action has been taken by

both Government departments likely to secure the object which the Committee of the Congress had in view.

XXII.—STANDARD OF COLOUR.

The Council have appointed a Committee to consider the practicability of formulating a standard of colour for industrial purposes. Such a standard would be of very great value for many reasons, and the Council have cause to believe that recent researches by Captain Abney and others, render its formation possible. If a satisfactory standard can be devised, there is no reason to doubt but that, if put forward under the authority of the Society of Arts, it would meet with general acceptance. The following gentlemen have consented to serve on the Committee:—The Attorney-General, M.P. (Chairman of Council); Sir Frederick Bramwell, Bart., D.C.L., F.R.S. (Deputy Chairman of Council); Lord Rayleigh, F.R.S.; Sir Villiers Lister, K.C.M.G.; R. Brudenell Carter, F.R.C.S.; Captain Abney, C.B., F.R.S.; Colonel A. C. Hamilton, R.E.; Professor Meldola, F.R.S.; Professor J. J. Hummel, W. Holman Hunt, Dr. Russell, F.R.S., J. Fletcher Moulton, Q.C., F.R.S.

XXIII.—CONVERSAZIONE.

The Society's Conversazione was held this year at the South Kensington Museum. The arrangements were the same as in previous years, the quadrangle, in addition to the galleries of the Museum, being lighted and available for visitors. The Council feel that the Society are much indebted to the Director of the Museum, Sir Philip Cunliffe-Owen; the Assistant Directors, Mr. R. A. Thompson and Major-Gen. Festing; and to the whole of the official staff of the Museum, for the trouble which they took on this, as on so many previous occasions, in making the arrangements for the evening work smoothly and satisfactorily. The number of visitors attending the Conversazione was exactly two thousand.

XXIV.—NEW COUNCIL.

The Council have, in accordance with the regulations, prepared, and submit the usual balloting-list for the election of Vice-Presidents, Council, and Officers. The following, being the four senior Vice-Presidents, of necessity retire:—Mr. Carpmael, Sir Daniel Cooper, Sir Villiers Lister, and Lord Thurlow. In addition to this, Mr. Francis Cobb also retires, in order that he may offer himself for the office of

* See Council Report for Session 1889-90, *Journal*, June 27th, 1890, vol. xxxviii., p. 739.

Treasurer, the duties of which he has so satisfactorily performed in previous years. To fill the vacancies thus caused, the following names are proposed:—Sir Frederick Bramwell, who served as Treasurer last year; Sir George Birdwood, who retires by seniority from amongst the ordinary Members of Council; General Donnelly and Sir Frederick Abel, both of whom are well known to the Members for the services they have rendered on the Council in previous years; and Mr. Wyndham Portal, an old and well-known member of the Society, who has never been on the Council before. Sir George Birdwood (as already mentioned), Sir George Chubb, General Michael, and Mr. Robins have to retire from the Council; and to fill the four vacancies thus caused, the Council propose Sir Saul Samuel, Mr. Francis Elgar, Professor Roberts-Austen, and Sir James Douglass. The last three named gentlemen are fresh to the Council; Sir Saul Samuel served on it before, but retired on his undertaking a voyage to Australia.

XXV.—LIST OF MEMBERS.

The total number of life members, subscribing members, and institutions in union which subscribe to the Society from their own funds, is now 3,352. During the year 1890-91, 308 members have been removed from the list by death or resignation. During the same period 298 have been elected.

XXVI.—OBITUARY.

The list of distinguished Members whose loss the Society has had to deplore during the past year is not a very long one, though there are in it some eminent names. Earl Granville was a Member of the Society of long standing, and took an active interest in it, having served during many years on its Council. The Archbishop of York was also a Member for many years, and, thirty years ago, acted for some time as one of the Society's Examiners. Sir Edwin Chadwick served on the Council in various capacities for a long time, and it was through the agency of the Society that very many of the important suggestions which he originated for the improvement of sanitation were made public. Sir Richard Burton, the distinguished traveller, contributed two papers to the Society, and received its Medal. Mr. A. J. Ellis also made valuable contributions to the Society's proceedings, the merits of which were acknowledged in the same way. Mr. Loftus Perkins, the

distinguished engineer and inventor, served for some time on the Council. Other names which should be mentioned are Canon Liddon, Lord Magheramorne, Mr. Hallowes, who for many years acted as the honorary Solicitor to the Society, and Mr. Shirley Hibberd, the well-known writer on horticulture. Obituary notices of all the above, and of other Members of the Society who died during the year just concluded, have appeared in the columns of the *Journal*.

XXVII.—FINANCE.

In accordance with the Bye-laws, the annual statement of receipts, payments, and expenditure for the financial year just concluded was published in the *Journal* of last week. While it affords gratifying evidence of steady and continuous prosperity on the part of the Society, it does not seem to offer any salient points which require explanation or suggest comment. The annual subscriptions for the year show a trifling increase, but the sum paid for life composition is considerably in excess of the amount received last year, being £567 as compared with £294. An item of receipts which did not appear last year is that of the Prize Fund donations, £76 10s. having been contributed by five of the city companies to provide prizes for the Examinations. A portion of this fund has been expended, and the remainder has been reserved for similar application next year.

On the other side of the account, the item of the *Conversazione*, £670, seems large; but from this is to be deducted the sum of £202 received from the sale of admission tickets, thereby reducing the amount to about the usual level. In addition to the amounts paid for life compositions, it has been found possible to invest the amount of £500. From careful estimates it would appear that the Society's assets show an excess of nearly £17,000 over the liabilities, £13,000 of this being represented by actual investments. In addition to this amount, the Society holds funds in trust amounting to £14,000 chargeable with various obligations in accordance with the several trust deeds.

The CHAIRMAN moved the adoption of the report, with which he thought the members had very great cause to feel satisfied, as it showed the Society was continuing the useful work it had been carrying on for so many years. Referring to the award of the Albert Medal to Sir Frederick Abel, Sir Frederick Bramwell said it must be a great satisfaction to the members that one, who had worked so

long and so ably for the benefit of the Society, should be the recipient of this honour. Alluding to the proposed examination of School Board teachers by the Society's examiners, he said it afforded valuable evidence of the high estimation in which the Society's examinations were held that an important body like the School Board for London should think it desirable to have the Society's certificate as to the proficiency of their teachers. In reference to the Society's finances, he agreed that they were in a satisfactory condition; the Society was able to pay its way and put by a little money; but the members should recollect that the lease of the Society's premises would expire in a few years, involving additional expenditure. He concluded by remarking that it was the duty of every member of the Society to assist in keeping up the number of its supporters.

Mr. MICHAEL CARTEIGHE seconded the motion for the adoption of the report.

Mr. MARTIN WOOD said that the influence of the Society in the provinces should not be overlooked, and he thought that in this respect the value of the examinations was considerable. The *Journal*, as a permanent record of the Society's proceedings, was especially valuable to country members and others prevented from attending the meetings. He regretted that the subject of political economy was to be omitted from the examinations.

The CHAIRMAN proposed a vote of thanks to the officers of the Society, which was seconded by Mr. COBB, and carried unanimously.

Sir GEORGE BIRDWOOD referred to the efficient manner in which the work of the Indian Section was carried on by the new secretary of the Section, Mr. S. Digby.

The SECRETARY (Sir Henry Trueman Wood) acknowledged the vote of thanks, on behalf of himself and the staff.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Edinburgh, K.G.	William Anderson, M.Inst.C.E., F.R.S.
H.R.H. the Duke of Clarence and Avondale, K.G.	The Attorney-General, M.P.
<i>Sir Frederick Abel, K.C.B., D.C.L., D.Sc.</i>	Sir Francis Dillon Bell, K.C.M.G., C.B.
Duke of Abercorn, C.B.	<i>Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.</i>

Sir Edward Birkbeck, Bart., M.P.	<i>Major General J. F. D. Donnelly, C.B.</i>
<i>Sir Frederick Bramwell, Bart., D.C.L., F.R.S.</i>	Sir Henry Doulton.
Maj.-Gen. Sir Owen Tudor 'Burne, K.C.S.I., C.I.E.	James Staats Forbes.
R. Brudenell Carter, F.R.C.S.	Sir Douglas Galton, K.C.B., D.C.L., F.R.S.
Lord Alfred S. Churchill.	Thos. Hawksley, F.R.S.
Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E.	General the Right Hon. Sir Henry F. Ponsonby, G.C.B.
Prof. James Dewar, M.A., F.R.S.	<i>Wyndham S. Portal.</i>
	Sir Robert Rawlinson, K.C.B.

ORDINARY MEMBERS OF COUNCIL.

Michael Carteighe.	George Matthey, F.R.S.
<i>Sir James N. Douglass, F.R.S.</i>	John Fletcher Moulton, M.A., Q.C., F.R.S.
James Dredge.	William Henry Preece, F.R.S.
<i>Francis Elgar, LL.D.</i>	<i>William Chandler Roberts-Austen, C.B., F.R.S.</i>
Alex. B. W. Kennedy, F.R.S.	<i>Sir Saul Samuel, K.C.M.G., C.B.</i>
Chas. Malcolm Kennedy, C.B.	
John Biddulph Martin.	

TREASURERS.

<i>B. Francis Cobb.</i>	Sir Owen Roberts, M.A., F.S.A.
-------------------------	--------------------------------

SECRETARY.

Sir Henry Trueman Wood, M.A.

The CHAIRMAN proposed the usual vote of thanks to the scrutineers, which was seconded by Mr. C. M. KENNEDY, and carried unanimously.

Mr. KENNEDY then proposed a vote of thanks to the Chairman (Sir Frederick Bramwell) which was seconded by Mr. DREDGE, supported by Mr. HYDE CLARKE, and carried unanimously.

Sir FREDERICK BRAMWELL, in responding, explained the absence from the meeting of the Chairman of Council, Sir Richard Webster, who was unavoidably detained by his duties at the House of Commons.

MEETINGS FOR THE ENSUING WEEK.

- MONDAY, JUNE 29...Geographical, Burlington-house, W., 8 p.m. 1. Mr. Alvan Millsom, "The Yoruba Country, West Africa." 2. Mr. Denis Doyle, "Journey through Gazaland with Gungunhana's Envoys."
- FRIDAY, JULY 3...United Service Institution, Whitehall-yard, S.W., 3 p.m. Prof. Vivian Lewes, "The Storage of Smokeless Powder on board her Majesty's Ships."
- Geologists' Association, University College, Gower-street, W.C., 8 p.m. Rev. Prof. J. F. Blake, "The Geology of the Country between Bridlington and Whitby, the district to be visited during the Long Excursion."

Journal of the Society of Arts.

No. 2,015 VOL. XXXIX.

FRIDAY, JULY 3, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday last, 29th ult., at their first meeting after the annual election, the Council elected Sir Richard Webster, M.P., as Chairman of Council, and Sir Frederick Bramwell, Bart., D.C.L., F.R.S., as Deputy-Chairman for the ensuing year. The various Committees were also re-appointed.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a Prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual National Competition held in 1892.

The prize is offered for the best original design for architectural decoration, by means of painting, stucco, carving, mosaic, or any other method, such as that for the side of a room or hall, a ceiling, or the apse or side of the chancel of a church. The design must be on imperial sheets, and must be accompanied by drawings of details on separate imperial sheets. Mere patterns or pieces of painting and modelling, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The work is to be that of the previous school year.

The designs are to be submitted in the usual manner to the Examiners, at the Annual Competition (April, 1892) of the Department of Science and Art. Competing designs must be marked, "In competition for the Stock Prize," in addition to being labelled and staged according to the regulations of the Department of the Science and Art.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a Prize of £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competitions held in 1892 and in 1893.

The prize is offered to the student who obtains the highest marks in the following stages of instruction :—

A finished drawing of imperial size from the nude living model.

Time studies from the nude living model.

Studies of hand and feet from the living model.

Also, in the 3rd Grade Examination, May, 1892, in drawing from the living model.

No student will be eligible for the award who has not taken a First-class at the Third Grade Examination, and who has not received marks for a drawing of imperial size. Neither of the other two subjects is obligatory, but a fair proportion of marks will be given for each.

The works must be those of the **previous** school year.

The drawings, &c., are to be submitted in the usual manner to the Examiners, at the Annual Competition (April, 1892) of the Department of Science and Art. Competing drawings, &c., must be marked, "In Competition for the Mulready Prize," in addition to being labelled and staged according to the regulations of the Department of Science and Art.

Proceedings of the Society.

CANTOR LECTURES.

THE ELECTRIC TRANSMISSION OF POWER.

BY GISBERT KAPP.

Lecture I.—Delivered February 16, 1891.

The transmission of power, in whatever way it may be effected, is one of the most important problems in applied mechanics. Strictly speaking, it enters into and is indeed precedent to the application of power to all industrial operations. The power developed in a Lancashire mill-engine only becomes of value to the

spinner or weaver after it has been transmitted to the mules or looms by the agency of ropes, belts, pulleys, and other gear. Without such gear effecting the transmission, the power developed by the local steam-engine would be as useless to the mill-owner as the power which may be contained in a waterfall miles away. In either case transmission must precede the application of power, but whilst in the former case the problem of transmission is simple, and has to be attacked rather from the point of view of convenient subdivision, than with particular regard to efficiency (this being naturally high with properly designed gear); in the latter case the problem is of a much more difficult character, and efficiency, combined with moderate capital outlay, small working expenses, reliability and safety, become matters of first consideration.

We have thus to distinguish between two kinds of power transmission, the one taking place over distances reckoned by feet or yards, and the other over distances reckoned by thousands of feet, or even by miles. When we speak of the electric transmission of power, we tacitly assume that it belongs to the latter class, and refers to distances beyond the reach of the ordinary gear such as shafting, cog-wheels, pulleys, and belts, employed for the subdivision and distribution of power within the walls of a factory; and it is in this generally accepted sense that I propose to bring the subject mainly before you. There are, however, cases where the application of electromotors to special tools is either the most convenient or only possible method of applying mechanical power to the performance of certain operations, and it will, therefore, be necessary at least briefly to glance at that part of our subject which is not usually comprised within the title of these lectures, namely, the transmission of power over very short distances by means of electric currents. We thus distinguish between "long distance" and "short distance" transmission, the fundamental distinction between the two being that in the former the transfer or transmission of power from one point to another, so to speak, in bulk, is our main object, whilst in the latter we rather aim at the subdivision and convenient application of power, in small quantities, at various points, and for particular purposes. I propose to consider long distance transmission first.

Broadly speaking, there are two ways in which we can transmit mechanical energy from one place to another. Let us assume,

by way of example, that the primary source of energy is coal, and that the power derivable from this coal is required, not at the pit's mouth, but at a mill a certain number of miles away. In such a case, the obvious, and also the most economical, way of transmitting power is to carry the coal to the mill, and burn it under the boiler of the mill-engine. Even if the distance between the pit and the mill is short, this method will be the best, provided there are no difficulties of transport. Suppose, however, that, although the distance is short, local conditions, such as great difference of level, bad roads, or total absence of roads, render the carriage of coal difficult or impossible, then we would establish our boiler and engine at the pit, generate the power there, and transmit it by wire rope, or in some other way, to the mill. In both cases we have transmission of power, but the methods are essentially different. In the first case we have transmitted, not mechanical, energy itself; but the thing from which mechanical energy can be obtained, namely the coal, each ton of which represents so many stored horse-power hours. In the second case we have transmitted the energy itself in its kinetic or potential form. In popular language we might describe the process as the transmission of "live" power, as distinguished from the transmission of "stored" power, which takes place when we carry coal from the pit's mouth to the mill.

The most important sources of power in nature are corn, coal, and falling water. Under the term "corn" I comprise all vegetable food-stuffs suitable for conversion into mechanical energy, by means of horses and other animal engines; whilst the term "coal" naturally includes all kinds of fuel suitable for conversion into mechanical energy by some form of heat-engine. The power derived from corn and coal is generally transmitted in the stored form; that derived from falling water in the live form, since the conveyance of water at a high level, or under considerable pressure, to great distances necessitates the erection of very costly works. To prevent misunderstanding, I must here point out that I use the term "stored energy," as applied to water, merely in its colloquial sense. We speak of the energy stored in the water of a mill-pond, but, in reality, the energy does not reside in the water at all, but is an effect of its elevated position, and is, therefore, not comparable with the energy which is chemically stored in coal. Leaving, however, such distinctions on

one side at present, we may regard water, which is being carried along horizontally, at a certain elevation, from one place to another, as the vehicle of so much stored energy, which we can obtain, in its live form, at any point at which we establish a water-engine, through which the water passes in its descent to a lower level. If we carry water along in this way, it is not with the object of bringing the stored power to the point of application, but merely to secure the largest possible fall, and, therefore, a maximum of power with a given quantity of water. If it be necessary to transmit the power farther, the transmission is generally effected in the live form. Now let us see what position electricity occupies in relation to these primary sources of power in nature, namely, corn, coal, and falling water.

In the first place it will be obvious that, where electricity is the transmitting agent, we can effect the transmission both in the stored and in the live form. To see this clearly, we need only for a moment revert to our example of the coal pit and the mill. Instead of sending the coal to the mill to be converted into power there, we could burn it at the pit, and thereby generate steam to be used for driving a steam dynamo. The current from the dynamo we could utilise in charging a storage battery, and send this to the mill, where it would drive an electromotor, thus taking the place of the local steam-engine. Here we have a system of transmitting energy in the stored form. On the other hand, if we do away with the batteries as a vehicle of energy, and connect the dynamo at the pit with the motor at the mill by a pair of insulated wires, we have a system of electric transmission of power in the live form. The latter system is that generally understood under the term "electric transmission of power," and therefore forms the principal subject of these lectures; but before entering upon it, I propose briefly to investigate the capabilities of electric transmission of power in the stored form.

As you all know, a sack of coal contains more stored power than a secondary battery of equal weight, and its carriage, whether by rail or road, is cheaper, easier, and requires less precautions than that of the battery. It is, therefore, quite obvious that, if the primary source of power is coal, and if there is no objection to the establishment of a steam-engine at the place where the power is wanted, it will be more economical to carry the power there in the form of coal than in the form of batteries; not only because of the saving in carriage, but

also on account of the smaller capital outlay, the smaller depreciation, and the avoidance of the loss of energy in the battery itself. But let us assume that the primary source of energy is falling water, then it is not so obvious at the first glance that its electric transmission in the stored form should be uneconomical. We cannot produce coal out of the energy of falling water, but we can charge batteries with it, and electricity would thus seem to offer a means of utilising a power of nature which would otherwise be lost. It might, perhaps, here be objected that electricity does not form the only means for utilising such a power, since there are various other ways in which power may be stored, a familiar example being compressed air. We might, therefore, also utilise the power of the waterfall for working an air-compressor, and store the air under pressure in steel reservoirs, to be used afterwards for working air-engines constructed similarly to ordinary steam-engines. Many such engines are actually in use in Paris on the Popp system, though there the air is conveyed to them by pipes under pressure, and not in storage vessels, as would be the case in our example. There can thus be no doubt that the transmission of power by stored air is practicable, but the question is at what cost will it be effected, and can it compete with transmission by batteries? The answer to these questions depends on two factors, namely, the storage efficiency, and the cost of transport. By storage efficiency, I mean the ratio of the power put into and taken out of the apparatus which serves as the vehicle for the power. Batteries may now be obtained in which this ratio is about 80 per cent.; that is to say, for every 100 horse-power hours put into the battery, 80 horse-power hours can be taken out. The storage efficiency of compressed air is very much smaller. The most reliable data under this head are to be obtained from the paper which Professor Kennedy read before the British Association in 1889, when he gave an account of experiments carried out at Paris on the Popp system. He found that the indicated efficiency with cold air was 39 per cent.; that is to say, for every 100 horse-power indicated by the compressing-engine, 39 horse-power were indicated in the engine driven by compressed air as it came from the mains. If the air before being admitted to the engine was heated to 320° Fahr., the apparent indicated efficiency rose to 54 per cent., but as the heat energy thus supplied to

the air requires the expenditure of fuel at the point where the power is wanted, the use of hot air really involves two methods of transmission—namely, that of power in the shape of air under pressure flowing through the mains, and that of power in the stored form contained in the fuel. To make the comparison with electric transmission of stored power a fair one, I must therefore take the efficiency of the Popp system when the air is not heated. A correction must, however, be made for loss of power in the mains. In the Popp system the power is transmitted in the live form by air flowing through pipes, and there is necessarily a certain loss on account of friction in the pipes and valves. As far as the friction in the pipes is concerned, this would not occur if the transmission were effected in the stored form by means of air carried under pressure in a reservoir, but, on the other hand, the loss by friction through valves would be greater, because it would be necessary to insert between the reservoir and the air-engine a reducing valve, which would regulate the supply of air as the pressure falls. The loss of power due to this circumstance will probably be greater than the corresponding loss in the Popp system, where the pressure is constant; but as I have no experimental data to determine this point, I take the same loss as found by Professor Kennedy—namely, 2 per cent., which makes the indicated efficiency nearly 40 per cent. The efficiency of the air-engine he found to be, with cold air, 67 per cent., making the total efficiency of the system 26·7 per cent. By adopting air storage we could therefore obtain 26 $\frac{3}{4}$ horse-power hours for every 100 horse-power hours indicated in the engine. Now let us see how the case stands with electrical storage. The efficiency of the steam dynamo, that is, the ratio of the electrical output to the indicated power, may be taken as 83 per cent.; that of the batteries 80 per cent., and that of the motor at least 85 per cent.; so that the total efficiency works out to quite 56 per cent., or more than twice that of the rival system. I have here assumed that the dynamo is steam-driven, simply because the only reliable figures I could obtain about compressed air referred to steam-driven compressors, but it is obvious that the comparison of the storage efficiencies of the two systems cannot be materially affected by the source of power, and will practically be the same in the case under consideration, where the power is supposed to be derived from falling water. We see that in

efficiency, at least, air storage is far behind electrical storage. Let us now inquire whether it is any better off in the other essential feature I have mentioned—namely, in the cost of carriage. The information available under this head is tolerably reliable as regards batteries, but this is not the case as regards air, stored under pressure. I know of no experiments made to determine accurately the weight of air reservoirs, and in the absence of such data I cannot do better than adopt the calculated figure given by Professor Osborne Reynolds in one of his Cantor lectures delivered in 1888. According to this authority, the weight of the steel reservoir and air contained would amount to 300 lbs. for every horse-power hour so stored. Now the weight of a secondary battery filled with liquid, and provided with a tray and connections, all complete, does not exceed 100 lbs. per horse-power hour stored, that is only one-third the weight of an equivalent air reservoir. We see, therefore, that as regards efficiency, air storage is twice as bad, and as regards weight it is three times as bad as electric storage. Competition with it is, under these circumstances, obviously impossible, and we may therefore say that if the transmission of power from the waterfall to a distant point has to be made in the stored form, electricity is the only agent which need be considered.

Whether it would pay so to transmit power is a question which cannot be answered off-hand. As compared with the direct transmission of live power by means of a pair of wires, the cartage of batteries up and down the country will no doubt appear to be a clumsy device, but when we are investigating the different possible solutions of an important problem we must not allow any preconceived opinions of what is elegant or clumsy to influence our judgment, we must, in fact, judge each case on its own merits, and I propose to deal with the electric transmission of stored energy in this sense. The system of power transmission by storage batteries is actually in use, not, indeed, for long distance transmission pure and simple, as above defined, but still for transmission over distances reckoned by miles. I allude to the electric tram-cars worked by storage batteries which are charged at a central depôt, and run for many miles before they require to be again charged. The object is not to carry a certain amount of power in bulk from one point to another, but to dispense whatever power is required for the propulsion of the car during the journey. We might,

however, imagine the tram-car, instead of being occupied by passengers, to be loaded with storage cells in addition to those it carries for its own propulsion. Whilst the latter would gradually lose their charge in transit between the two terminuses, the former would arrive fully charged, and could be made to give up part of the power stored in them at the starting point. Here we have transmission of power in the stored form, but let us return to our example of the waterfall and the mill, and see how such a system might be put into operation.

At the waterfall we establish the necessary hydraulic works, and an electric station where the batteries can be conveniently charged. We further build a tram line or railway, joining the charging station with the mill where the power is wanted, and we design the rolling stock with special regard to the safe and convenient carriage of the batteries to and fro. The train is fitted with electromotors, so as to make it self-propelling. A train load of charged cells is thus taken to the mill, and left there to work the electromotor which supplies power to the mill. During this process the batteries become gradually exhausted, and must be disconnected from the motor before they are quite exhausted, because we must allow a sufficient margin of power for taking the train back to the charging station. The economy of the whole system will evidently be the greater the less power is spent in the outward and home journey; and we might call "efficiency of transmission" the ratio of the power actually delivered to the motor, and that which might be so delivered if the battery were used for working a motor at the charging station itself: in other words, if the distance of transmission were nought. Say, for instance, that a total of 1,000 horse-power hours could be obtained from the battery, if it were discharged immediately, and that the power spent in the outward journey amounts to 50 horse-power hours, then a further 50 horse-power hours will have to be spent in the return journey, and the power obtainable at the mill will only amount to 900 horse-power hours. The efficiency of transmission will, in this case, be 90 per cent. If we double the distance between the waterfall and the mill, the efficiency of transmission would be reduced to 80 per cent; if we treble the distance, the efficiency would only be 70 per cent., and so on. The efficiency must naturally depend on the kind of road over which the transmission takes place: it will be small on a common

carriage road, larger on a tramway, larger still on a railway, and largest on a canal. We can, for every arrangement, express the value of the system, as far as economy of power is concerned, in one of two ways. We can, if the distance is fixed, give the efficiency in the usual way as a per-centage, or we can fix a standard per-centage of efficiency, and ascertain the distance over which this standard is attainable in any particular case. I shall adopt the latter way of reckoning, as the more convenient for comparison with other methods for transmitting power, whether in the stored or live form.

First, as to transmission of stored power otherwise than by batteries. The only two methods we need consider are the carriage of corn and the carriage of coal, each combined with the use of a proper engine for converting the stored into live power at the other terminus of the line of transmission. In the case of corn, the starting point of this line is the field where the corn is grown. We there load it into suitable vehicles, and send it to the mill where the power is wanted. Since we are dealing now entirely with animal power, we must suppose the cartage to be effected by draft animals, say horses, and the conversion of corn into live power at the mill also by such animals. I need hardly say that, at the present time, no English mill-owner would dream of working his mill in this fashion by animal power, since coal is yet abundant, and a single steam-engine is a far cheaper and handier instrument for producing and controlling a large amount of power than an equivalent number of horses. On the other hand, if power is required in small quantities, and in particular ways, then the horse will produce this power better, more cheaply, and more conveniently than the steam-engine. It may seem absurd to work a large cotton mill by horse gear, but substitute for the mill a farm, and you see at once that the transmission of stored power to it, in the shape of corn, is a necessary part of the agricultural operations. Now the horses, in bringing the corn to the place where the power is required, perform work and must consume an equivalent amount of food. They also perform work in bringing the empty carts back again to the field to be re-charged. The ratio between the amount of corn delivered at the mill and the amount taken out of the field would therefore represent the efficiency of transmission. If this is to be 90 per cent., as in the case of electric transmission, we may take it that, for every

100 sacks of corn taken away from the field, the horses would eat on the outward journey (when the carts are heavily laden) $6\frac{1}{2}$ sacks, and on the homeward journey (when they are empty) $3\frac{1}{2}$ sacks, leaving 90 sacks of corn to be converted into live power at the mill. The distance to which we can thus carry stored power with a standard efficiency of transmission is a measure of the merit of the system, as far as economy of power is concerned.

The transmission of stored power in the shape of fuel is a parallel case. We load the coal at the pit's mouth into waggons, and haul them by means of locomotive engines to the places where the power is wanted. Part of the coal is consumed on the outward and homeward journey of the train, leaving the rest for the production of live power at the mill. If this amounts to 90 tons out of every 100 tons put on the train at the pit's mouth, we have again an efficiency of transmission of 90 per cent.

I have already mentioned that the exact distance to which we can carry power by either of the three agents here mentioned (namely, batteries, corn, and coal), depends very much on the kind of road over which the transmission takes place. We might assume an almost infinite variety of cases, but, as our object is to obtain a rough general comparison of the different systems rather than exact figures for any one of them, I have assumed merely three kinds of roads, namely, a common carriage road, a tramway, and railway, and have calculated the distance to which power can be transmitted in each case with a loss of 10 per cent. The results of these calculations are given in the following Table. The speed of transmission has been assumed at four, six, and twenty miles for road, tram, and rail respectively, when coal or batteries are the transmitting agents; and at four miles on all kinds of road when corn is the transmitting agent. In all cases I have assumed that the road is the best of its kind, perfectly free from gradients or curves, and that the traffic can be worked at the speeds mentioned without interruption. In reality, these conditions will of course not all be fulfilled; we have to make allowances for waste of power on gradients, curves, bad places in the road, for running at variable speed, and for stopping and starting. The distances given in the Table are therefore throughout too large, but as our purpose is merely the comparison of the different systems, we may take the figures in the Table as a rough indication of the merits of each.

TRANSMISSION OF STORED POWER.

Source of Power.	Distance in miles attainable with 90 per cent. efficiency of transmission over—		
	Road.	Tram.	Rail.
Coal and Steam Engine	115	270	1,300
Corn and Horse	52	170	440
Storage Battery and } Electromotor }	4	10	26

You will see, from this Table, that as regards efficiency, the electric transmission of stored power cannot compete with the other two methods. A horse and cart carrying corn over an ordinary carriage road works with twice the efficiency of the electric locomotive taking batteries over a railway. The discrepancy is still greater if we compare the electric locomotive hauling batteries with the steam locomotive hauling coal. The latter can transmit power over a distance fifty times that over which the former can transmit power with an equal efficiency. On a tram line the distance over which we can transmit power with an efficiency of 90 per cent. is, according to the Table, 10 miles, that is to say, if the whole load of the car is composed of batteries, we can run it 10 miles out and 10 miles home at an expenditure of 10 per cent. of the total charge of the batteries. Now let us see how this compares with the storage cars in use on passenger tram lines. The total weight of a full-sized car is about 10 tons, made up somewhat as follows:—Car and propelling gear, 4 tons; batteries, $2\frac{1}{2}$ tons; passengers, $3\frac{1}{2}$ tons. If the $3\frac{1}{2}$ tons represented by the passengers were utilised for additional storage cells, the car could run 20 miles with the loss of 10 per cent. of its charge; or it could run 200 miles if losing the whole of its charge. As there are, however, only $2\frac{1}{2}$ tons of batteries instead of 6 tons, it can only run 86 miles. This is according to the Table, and more than attainable in practice, for the reasons already stated. Experience has shown that storage cars can only run from 30 to 60 miles with one set of batteries, or half the distance stated in the Table. If we apply the same reduction to all the methods of transmission, we find that the distances to which power can be carried electrically in the stored form, with an efficiency of 90 per cent., are 2, 5, and 18 miles over a carriage road, tramway, and railway respectively.

The efficiency of transmission is, however, not the only or even the most important con-

sideration in the problem of transmitting power to a distance. The owner of a transmission plant cares nothing for any theoretical perfection in the way of high efficiency. All he cares for is the cost at which the power is delivered to him. All other things being equal, high efficiency will naturally reduce this cost, and in so far is an advantage, but in practice all other things are not equal, and to aim at high efficiency regardless of other considerations is the reverse of good engineering. It is no doubt gratifying to the engineer if he can point to a transmission plant designed by him to give some extraordinarily high efficiency, but if this result has been obtained by means of an exorbitant capital outlay and excessive working expenses, it will not be equally gratifying to his employer, the owner of the installation, who has to pay for its erection and working. It therefore becomes the duty of the engineer so to plan the installation that the cost of the power delivered shall be a minimum under any given circumstances.

We have seen that, as judged by the efficiency standard alone, electric transmission of power in the stored form is hopelessly behind the other two methods which we compared with it. Let us now see whether this is or is not the case if we judge the system by the more practical and, indeed, the only reliable test of cost. It is of course understood that in estimating the annual cost at so many pounds per horse-power delivered, we take into account not only the cost of coal burnt throughout the year, if we obtain the power by steam, or the rent for water, if we use a turbine, but also all other expenses which may properly be charged to the power account, such as wages for the attendants, petty stores, interest, repairs, and depreciation of plant. Estimated in this way, the cost of water power will be found to vary between £2 and £8 per annum, the exact figure depending, of course, on the total amount of power available, the quantity of water, its fall and local conditions, which must largely influence the cost of the hydraulic works. The cases where water-power can be had at so low a price as £2 a year are exceptional; on the other hand, if we have to pay as much as £8 a year for water-power, it will seldom be worth while to transmit it electrically, or in any other way; and I shall, therefore, assume £3 and £6 as the limits of cost for water-power intended for electric transmission. The cost of steam-power, if produced by large economical engines, is generally taken at £10 per year;

if produced by small, and therefore less economical engines, it may rise to £20, and even £40 per year. I shall further assume that in all cases the power is required for 3,000 hours during the year, that is, 300 work-days of 10 hours. At the outset, it is clear that if we wish to transmit large parcels of power—say 100 horse-power and upwards—by storage batteries, we must be able to deliver the power at a cost not exceeding £10 a year; for were the cost higher, it would obviously pay better to establish a local steam-engine. I have already mentioned that a system of battery transmission can be made to yield 56 per cent. efficiency, if we allow 10 per cent. for the transmission itself. To deliver 100 horse-power we must, therefore, charge with 178 horse-power during a time equal to that during which the power is required. If, therefore, at the generating station the annual horse-power costs £3, the charge for power alone will be £5 6s. at the receiving station. To this must be added the cost of labour and the interest and depreciation of plant, which, in this case, consists of the generating dynamo, motor, batteries, and line of transmission, with its equipment of locomotives and waggons. The small storage cells, as now made, for lighting and power purposes, cost about £40 per horse-power; but let us assume that the larger cells, such as we would require, could be had for £30 per horse-power, then a battery to work a 100 horse-power motor would cost £3,330. In order to economise carriage, and to reduce the wear and tear of cells, it would be advantageous to have two batteries, one being charged while the other is at work. We have thus an initial outlay of £6,660 for batteries alone. The interest and depreciation on these will certainly not be less than 15 per cent., or £10 per horse-power. Add to this, the cost of power at the generating station, that of labour and interest and depreciation on the electric machinery and the line, and you will see that it is quite impossible to compete with battery transmission against a local steam-engine, if the power produced by the latter costs £10 per annum. But how does the case stand, if the amount of power required is so small that it cannot be produced at this low figure. If we want only 5 horse-power, and if we produce it by a local steam or gas-engine, we shall have to pay for each horse-power £20 to £40 per annum. Will it, in this case, pay to transmit, by means of batteries, the power produced by a large and economical steam-engine at some central station? If we have to build a tram-

way or railway for this purpose specially, it will certainly not pay; but let us assume that a tramway already exists, and let us investigate whether the company, which we suppose is working the line by storage cars, could afford to sell to a customer on the line power at a cheaper rate than he could produce by a local engine. Let us assume, by way of example, that the customer requires 5 horse-power for 10 hours daily. The battery to work a 5 horse-power motor will weigh about $2\frac{1}{2}$ tons, and cost £170. The charging dynamo, motor, and regulating gear will cost about £150, so that the whole capital outlay, if we provide two batteries, will amount to £490.

Now let us see how such a system of transmission will have to be worked, and what the working expenses will be. I take, by way of example, five miles as the distance between the generating station, which may be the tramway dépôt or a central electric-light station on the line of tramway, and the delivery station. At either terminus we must have mechanical appliances for loading and unloading the batteries from the car, such as are generally used in connection with storage cars. Early in the morning a charged battery is put on the car, and run out to the delivery station, where it is unloaded and connected to the motor. The other battery, which has served during the previous day, is loaded on the car and taken back to the dépôt to be charged up again. In this manner the car need only make one journey out and one journey home daily. As its speed may be very moderate, say from three to four miles an hour, the cost of running this car will be much less than that of a passenger car, which must stop and start every few minutes, and run at a higher speed. I take 3d. per car mile as the cost of haulage, including the use of plant, and I further allow 2s. a day for labour in loading and unloading the batteries. The account of working expenses will now stand somewhat as follows:—

Power at generating station at £10, allowing 65 per cent. total efficiency*	£	s.	d.
Haulage	77	0	0
Labour	37	10	0
15 per cent. interest and depreciation on batteries (£340)	30	0	0
10 per cent. interest and depreciation on electric machinery (£150)	51	0	0
15	0	0	
Total annual cost....	£210	10	0

* In this case, the efficiency is the ratio of the power supplied to the charging dynamo to that obtained from the motor, and does not include power spent in transmission, being charged for in the account at 3d. per car-mile.

This works out at £42 2s. per annum per horse-power delivered, and is therefore quite as high, if not higher, than the cost of power obtained by a small and uneconomical local engine. On the score of economy there is consequently no advantage in transmitting power by storage batteries in the present case, where the distance of transmission is five miles. Had the distance been less, the working expenses would also have come out smaller, but not by any considerable amount. The only item in which we could save is cost of haulage, and if we neglect this altogether we have still to pay £34 12s. per annual horse-power delivered. Battery transmission can therefore not compete against power produced by a local engine, even if the latter be of the rather uneconomical type which users of small power still tolerate. But how stands the case if for some local reason the employment of a heat-engine of any kind is precluded? We have then the choice between electric transmission by means of batteries, and directly by means of a pair of wires. Which will be the more economical? As the dynamo and motor, except, perhaps, in the matter of voltage, will be the same in either case, the answer to this question turns upon the comparison of the batteries and line of wires. The first question to consider is whether our wires may in the case of direct transmission be carried overhead on poles and insulators, or must be put underground. If the former be the case, the line need not cost more than £130 per mile; and I may at once mention that from the experience gained with various power transmissions, which I hope to bring before you, this item can be estimated with a fair degree of accuracy. As I shall have to deal more in detail with the cost and construction of live power transmission plants later on, I shall not enter into details at present, and must ask you to take my statements as to cost of line and cost of power transmitted as correct, though I do not now show how the account is made up. As regards transmission by wires placed underground there is, as far as I know, no example of such an installation, and we can therefore not verify our estimate by reference to work actually executed, as we can in the case of overhead transmission. We are thus forced to calculate the cost of the line according to the data obtainable for electric light mains, and I take for this purpose an estimate made by Mr. Crompton in his paper on "Central Station Lighting," read before the Institution of Electrical Engineers, on the

12th of April, 1888. In this paper Mr. Crompton gave Tables for the cost of underground mains of various types and sizes, and by reference to his tables I find that a main of the section required for the transmission of 5 horse-power, and insulated so as to safely bear a pressure of 1,000 volts, would cost about £670 per mile. We have now all the necessary particulars for making a comparison of the cost of battery transmission and direct transmission, the latter by both overhead and underground wires. The following Table gives the result. The cost includes the charge for power at the generating station (taken at £10 per annual horse-power), and interest and depreciation on the plant, which is taken at 15 per cent. for the batteries, and 10 per cent. for the line and electrical machinery.

TRANSMISSION PLANT FOR 5 HORSE-POWER.

Distance of Trans- mission in miles.	Annual Cost per horse power delivered, if the Transmission is		
	By Batteries.	Direct.	
		Overhead.	Underground.
1	£ 30·1	£ 22·8	£ 33·6
2	37·6	25·6	47·2
3	39·1	28	60
4	40·6	30·6	74
5	42·1	33	87

We see from this Table that if there is no objection to an overhead line, the electric transmission of stored power by means of batteries cannot compete against the direct transmission of live power by means of a pair of wires, even if the distance is considerable. But in towns we cannot have, or at least we ought not to tolerate, overhead lines, and if we work with an underground line we find that, for distances exceeding one mile, the battery is a more economical transmitting agent than the wire. Here we have at last found a case where it will be advantageous to transmit power by means of storage batteries, but there are so many conditions attached to the case that the field of application of such a system must necessarily remain very limited. First, the power must be required, so to say, in small parcels; secondly, there must be a tram line handy, and the customer must have facilities for loading and unloading the batteries and accommodating them on his premises; thirdly, there must be a charging station on the line having similar facilities; fourthly, the use of an overhead line must be excluded; fifthly,

the distance must exceed one mile; and, finally, there must be some reason why a local engine cannot be used. I need hardly point out that a system of transmission fenced in by so many conditions cannot have any commercial importance. Thus far, the result of our investigation is entirely negative. We find that transmission of power by means of storage batteries, whether the power transmitted be large or small, is not so economical as other methods of transmission, and has, therefore, no commercial value for all cases where these other methods are applicable. If I have, nevertheless, devoted some part of this lecture to the subject of battery transmission, it was because the idea of distributing power, so to speak, bottled up in batteries, seems to have a fatal charm for many inventors. It is an old idea, but is always coming up again, and for this reason I thought it advisable to go a little into figures and show you how the case really stands. It might perhaps be objected that as no distribution of stored power by means of ambulant batteries has as yet been practically introduced, it is premature to give an opinion as to the possibilities of such a system. The idea of battery distribution of power is, as a matter of fact, entertained not only by amateur electricians, but also by practical engineers. As an example of this fact, I may quote a passage in a report written about two years ago by Mr. J. F. Fanning. This gentleman, reporting to the Cataract Construction Company on the question of utilising the power of Niagara Falls, says: "Power and lighting currents may be electrically transmitted to neighbouring cities, and possibly storage batteries may be electrically charged and recharged, and many times forwarded for use in surrounding cities." When writing this, Mr. Fanning had, of course, in view cheap water-power, and probably canal transportation. If, at the same time, batteries could be made cheaper, lighter, and more durable than they actually are at present, then, but not until then, will they become commercially possible as transmitting agents in competition with other systems of power transmission. Taking batteries as we find them at present, their use as agents in the transmission of power is only justifiable in cases where the direct transmission by means of conductors cannot be employed; and this brings me to the consideration of the only case of the electric transmission of stored power which, as yet, has attained to practical importance—namely, the use of batteries for locomotive purposes.

Although electric tram-cars come strictly speaking within the title of my lectures, I do not propose to consider them at any length, the reason being that this branch of power transmission alone, if treated in detail, would absorb all the time at my disposal. I shall, therefore, content myself in taking up the subject only so far as is necessary to show in a general way what is the present practice in this branch of power transmission.

We have in this country two very good examples of battery tram-cars, the one being the cars now running in Birmingham, and the

other the cars on the Barking-road line in the North of London. Of the former I have not been able to obtain much information, but of the latter I have by the kindness of Mr. Thomas Frazer, who superintended the erection and working of the plant, been able to obtain all the information required for my purpose. I am also indebted to Mr. Reckenzaun for information regarding his cars, which are in use at Philadelphia. The following Table gives the principal data of these cars conveniently arranged for comparison and reference:—

STORAGE-BATTERY TRAM-CARS.

	Birming- ham.	Barking- road.	Philadelphia.	
			Small car.	Large car.
Weight of car (in tons)	—	3·275	2·500	3·620
„ „ motors and gear (in tons)	—	1·360	·980	1·140
„ „ batteries (in tons)	2·850	2·400	1·770	2 450
„ „ passengers (in tons)	3·300	3·600	2·230	3·600
Total rolling weight (in tons)	10·50	10·63	7·48	10·81
Per-centage of paying load	31·5	34	30	33·2
Number of cells	96	96	84	116
Maximum current	—	70	70	80
Maximum energy at battery terminals (electrical horse power)	—	19	14	23
Average energy at „ „ „ „ „ „)	—	6	4·8	5·4
Maximum energy per 10 tons of rolling weight (electrical horse-power)	—	17·8	18 7	21·3
Average „ „ „ „ „ „ „ „	—	5·65	6·42	4·95

Taking the averages of the last two lines in the Table, we find that for a car representing a total rolling weight of ten tons, we require a battery capable of giving a maximum output at its terminals of 19 electrical horse-power, and a mean output of 5·6 electrical horse-power. It must, however, be noted that the latter figure applies to the time the car is actually in motion, and does not include the power wasted in starting. Mr. Fraser has made very careful observations of the power flowing out of the batteries during the whole of the time the car is in service, and found that the integrated power divided by time come to 7·33 electrical horse-power; that is to say, a motor taking from the batteries all day long 7·33 electrical horse-power, will take from the batteries the same amount of power that is actually taken under the intermittent work going on in the running of a tram-car. Of the 7·33 electrical horse-power, a good motor will yield about $6\frac{1}{2}$ brake horse-power. Taking

the efficiency of the batteries at 60 per cent., a figure by no means too low when we consider the very irregular nature of the work done by these batteries when in service, we find that the electrical horse-power of the charging dynamos required per car is about 12 electrical horse-power. The ratio between the indicated power of the engine and the output of the charging dynamo may be taken at 80 per cent., so that we shall have to provide engine-power at the rate of 15 indicated horse-power for every car, provided the engines are worked for the same number of hours that the cars are in service. If the engines are worked for a longer time, say by night as well as by day, a corresponding reduction in the total indicated power of the station can of course be made.

Returning now to the subject of the cost at which stored-power can be retailed by electric transmission to small consumers, let us briefly glance at the rival system, namely, the distribution of small parcels of live power from a

central electric light station. One hears it often stated that the supply of power, and not that of light, must become the chief business of such stations. The argument in support of this view is somewhat as follows :—The demand for light is very uneven, being less than a tenth of the capacity of the station for many hours during the day, and rising very rapidly towards evening. The period of large demand comprises only a few hours, and during that time the engines work with great economy. During the remainder of the day the economy is less ; and, in fact, the greater portion of the coal bill, cost of attendance, and interest on the capital outlay is chargeable to light running. If, therefore, by the sale of power, we could keep the central station plant economically working during the whole of the day, the increase in the working expenses would be slight, but the increase of revenue would be very considerable. This argument is perfectly sound, but it has the rather serious defect that it will not convince the very people from whom this large increase of revenue is to

be obtained ; for, let us see what it means to the user of power. As you know, electric current is supplied from central stations, at a charge varying from 4½d. to 8d., and even 1s. per Board of Trade unit. The usual charge in London is about 7d. Now, suppose a small manufacturer, requiring only a few horse-power, determines to discard his small steam or gas-engine, and put up an electromotor, to be worked by current from a central station, what will the power cost him ? This, of course, depends on the time—that is, the number of hours in the year during which he requires power. If he has a small factory, in which work is steadily going on day by day, you may estimate that the power will be required during 3,000 hours per annum. It is now very easy to calculate the annual cost of each brake horse-power. Allowing £1 10s. per horse-power for depreciation and interest on themotor, and £1 for petty stores, we find that, at 7d. per unit, the annual horse-power comes to £75. With current at a different price, the cost of power will be accordingly altered, as shown in the Table :—

POWER DERIVED FROM A CENTRAL STATION.

Cost of Board of Trade)	d.	d.	d.	d.	d.	d.	d.
unit)	1	2	3	4	5	6	7
Cost of annual brake horse-)	£	£	£	£	£	£	£
power for 3,000 hours ..)	12'9	23'3	33'5	43'9	54'2	64'5	75
							85'4

It is clear, from this Table, that the small user of power will only use an electromotor if he can get current at about 3d. per unit, and, unless electric light companies can supply at this price (which at the present time does not seem likely) there is no prospect of supplying electric power to small factories wanting the power continuously. Another disadvantage is that the demand for power must, in winter at any rate, overlap the demand for light, thus requiring the erection of additional plant. If, however, the power is only required intermittently, then the electromotor is by far the cheapest instrument for producing it, not only as regards first cost, but also as regards working expenses. There are many small trades in which power is wanted only for a few hours during the day. If, for instance, the actual running time of a lathe is two hours daily, then the cost of the annual horse-power, with current at 7d. would only be £15, a figure which cannot be touched by either steam or gas. There is the further advantage of having the power always ready. There is no need to get up steam, look to the feed pump, open cylinder cocks, turn the engine over the centre, and generally do the dozen

little things which are required in starting an engine. With a motor all that is required is to turn on the switch when the power is wanted and to turn it off again when the job is done. For domestic purposes again, nothing could be more handy and economical than electric power supplied from a central station. I have here a collection of appliances, for the loan of which I have to thank the Keys Electric Company, and I can show you how easy and convenient it is to apply electric power to small domestic machinery.

I have in the present lecture dealt with what may be termed general questions of engineering policy rather than with technical details, and I am afraid you will have found the financial parts of the lecture rather a dry subject. The question of cost is however of the utmost importance in engineering work, and it was therefore necessary to give it some consideration. In the remaining two lectures I shall be able to turn to the more interesting parts of our subject, and bring before you some of the scientific principles and technical details relating to the electric transmission of live power over long and short distances.

Miscellaneous.

PHŒNICIAN COMMERCE.

The following memorandum, by Sir George Birdwood, on the myth of the second birth of Dionysus, as connected with the development of Phœnician commerce and the country of the cinnamon tree, is taken from Louis Dyer's *Studies of the Gods in Greece*, 1891:—Herodotus (iii. 111) says, "Some relate that it [κιννδάριον] comes from the country in which Dionysus was brought up;" and (iii. 97), "The Æthiopians bordering upon Egypt . . . and who dwelt about the sacred city of Nysa, have festivals in honour of Dionysus;" and again (ii. 46) he says, "But Dionysus was no sooner born than he was sewn up in the thigh of Zeus, and carried off to Nysa, above Egypt, in Æthiopia." Now there are several Nysas. Herodotus meant Nysa in Æthiopia, that is, the Troyloditic country beyond the Soudan; for the Soumali country is the cinnamon country. On the other hand, the story of Dionysus, "the Assyrian stranger," is, *inter alia*, a myth of the development of Phœnician commerce, of which wine was everywhere throughout the eastern Mediterranean (Levant) the staple; and the Greek myths, associating the wine god with Mount Meroe, in Æthiopia, probably arose from the fact that, in the original Phœnician myth, he was not a "child of the womb," but "of the thigh" (μυρός). That is to say, these myths probably arose at the time when kinship among men had ceased to be traced through their mothers, and had already begun to be traced through their fathers. Similarly, the association of the wine god with "Nysa above Egypt" was presumably due to there having been a Nysa near Meroe, and to his Greek name being Διόνυσος, this Greek form of his name being probably a folk corruption of his Phœnician name, which would almost certainly end in nisi "man." Of course, the cult of the vine and the manufacture of wine did not arise in Æthiopia, but on the slopes of the Indo-Caucasus; and hence Mount Meroe [Meru] and the Indo-Caucasian Nysa have been identified as the seats of the education of the young Διόνυσος.

Notes on Books.

COLOUR MEASUREMENT AND MIXTURE. — By Captain W. de W. Abney, C.B. London: Society for Promoting Christian Knowledge, 1891.

This little volume forms one of the series which the Society for Promoting Christian Knowledge are publishing under the title of "The Romance of

Science." It embodies the results of Captain Abney's recent researches in the subject of colour, and includes much of the material which he brought before the members of the Society of Arts in the course of lectures which he delivered on the subject during the past Session. The whole subject is dealt with. Early in the volume a description is given of the apparatus devised by Captain Abney and General Festing for selecting from the spectrum any portions required, and combining the selected portions in one colour patch on a screen, so that by their combination, together with the addition of varying amounts of unaltered white light, any possible tint can be produced. The whole book may be said to be founded on the results which have followed from investigations conducted by means of this apparatus, and the subject is certainly carried much further on than in any elementary book—it might almost be said in any book—on the subject.

LONDON: illustrated by twenty bird's-eye views of the principal streets originally compiled by the late Herbert Fry, revised and enlarged and brought up to date. London: W. H. Allen and Co. 1891.

This useful guide to the London of to-day is in the eleventh year of its publication. It contains a large amount of information, and the bird's-eye views specially referred to in the title give a distinctive character to the work.

General Notes.

OLIVE OIL IN SPAIN.—The *Board of Trade Journal* contains the following information, taken from the *Gazeta Mercantil*, respecting the production of oils in Spain:—The yield each year amounts to about 300,000,000 kilos. of oil, of which nearly half, or 147,600,000 kilos. represents the production of the provinces of Andalusia, Cordova, Seville, and Jaen. Of the 49 Spanish provinces, including the adjacent islands, only 17 do not cultivate the olive. These are Alava, Burgos, the Canaries, Corunna, Guipuzcoa, Leon, Lugo, Orense, Oviedo, Palencia, Pontevedra, Santander, Segovia, Soria, Valladolid, Vizcaya, and Zamora. Further, 14 provinces produce only the oil necessary for the consumption of their inhabitants. These are Alicante, Almeria, Avila, the Balearic Islands, Barcelona, Cadiz, Cuenca, Grenada, Guadalajara, Huesca, Logrono, Madrid, Navarre, and Salamanca. The latter produces the least oil, 437,000 kilos. The province of Cordova produces the most, 55,200,000 kilos. The province of Seville produces 4,945,000 kilos., and Jaen 3,588,000 kilos. There are consumed about 138,000,000 kilos. of oil in Spain; there only remains, consequently, an excess of 162,000,000 kilos. for exportation. The latter goes to South America, the Antilles, England, France, and Portugal.

Journal of the Society of Arts.

No. 2,016. VOL. XXXIX.

FRIDAY, JULY 10, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

FOTHERGILL PRIZE.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire.

A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres or other places of public amusement.

In cases where the invention is in actual use, reference should be made to places where it could be inspected.

A full description of the Invention, accompanied by such drawings or models as are necessary for its elucidation, must be sent in on or before the 31st December, 1891, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding the Prize, in case there is nothing in their opinion deserving the award, or sufficiently complying with the conditions, sent in for competition.

Proceedings of the Society.

CANTOR LECTURES.

THE ELECTRIC TRANSMISSION OF POWER.

BY GISEBERT KAPP.

Lecture II.—Delivered February 23, 1891.

FUNDAMENTAL PRINCIPLES.

The fundamental principle on which the electric transmission of power depends is that

peculiar, and, I might almost say, mysterious interaction between magnets and currents, which we comprise under the name electro-magnetic induction; but more particularly two special cases of electromagnetic induction, the one discovered by Oersted and the other by Faraday. Oersted discovered that, under certain conditions, a compass needle is deflected by an electric current, and Faraday discovered that relative motion between a magnet and a closed conductor will, under certain conditions, produce a current of short duration in the conductor. Oersted's effect is a permanent one; the needle remains deflected as long as the current flows. Faraday's effect is transient; the current flows, not as long as the magnet is present, but only during the time that it takes to change the relative position of magnet and closed conductor.

It is clear that, in Oersted's experiment, the movement of the needle is due to the action of a mechanical force between the magnet and the coil. In Faraday's experiment the transient current must be caused by a transient electromotive force, and this, in its turn, is caused by the relative movement between the coil and magnet. The modern method of explaining these things is based on the conception of magnetic lines of force, and the looping of these lines with the wire coil through which the current flows. The whole subject has been so admirably laid before this Society in the Cantor Lectures on the Dynamo, which Professor S. P. Thompson delivered here in 1882, that I need not occupy time by going over the same ground again, but may take it for granted that you are familiar with the lines of force theory. In modern language we may therefore explain the two fundamental phenomena somewhat as follows:—

1. The looping of a current with magnetic lines of force sets up a mechanical force between the conductor and magnet (or its equivalent).

2. Relative movement between a magnet (or its equivalent) and a wire coil sets up in the latter an electromotive force.

It follows immediately from these two propositions that looping and movement combined will require the expenditure of power, or yield power, accordingly as the movement is opposed to or in the direction of the mechanical force produced by the looping. In other words, that we can, by these simple means, convert mechanical into electrical power, or electrical into mechanical power. If we carry out both processes at the same

time, that is, if we combine Faraday's with Oersted's experiment, we require, of course, a pair of wires between the two converting instruments. In Faraday's experiment, if we thrust the steel magnet into the wire coil, we expend mechanical power, which is converted into the electrical power represented by a current flowing under a certain, though in this case very small, potential difference. The power represented by this current is again reconverted in Oersted's experiment into mechanical power, which is used to produce the deflection of the magnet. The total amount of power thus transmitted from one place to another is, of course, exceedingly small, but the same principle, applied on a larger scale, effects the transmission of many horse-powers, and it will be my task to show you how this is done in practice.

Before entering upon this subject, I must explain an expression used, in stating the fundamental principles on which the electric transmission of power is based. I said that we require a coil and a magnet "or its equivalent." The equivalent of a magnet is, as you know, a coil through which a current flows, and the experiments ought therefore also to succeed if instead of the magnet we use such a coil. In practical work we use neither a steel magnet nor a coil alone, but a combination of a coil with an iron core constituting what is known as an electromagnet.

You know that according to our modern conception of magnetic fields, there emanates from each pole of a magnet a certain flow of lines of force; and when we thrust a magnet into a coil we cause the individual wires of the coil to cut through the lines of force. The quicker the movement, that is to say, the more lines of force are cut by each wire in unit time, the greater is the E.M.F. produced; and the more wires are contained in the coil the greater is the E.M.F. produced, since the E.M.F. impulses of the different convolutions are added. It is also easily seen by experiment that the stronger the magnet the greater will be the E.M.F.; so that we find that the E.M.F. is proportional to the product of strength of field, speed of cutting, and length of conductor. Denoting these quantities respectively by H , v , and l , the E.M.F. produced is in C.G.S. units $H v l$, and remembering that a hundred million C.G.S. units of E.M.F. are equivalent to one volt, we have the E.M.F. in volts given by the expression

$$\text{Volts} = H v l 10^{-8}.$$

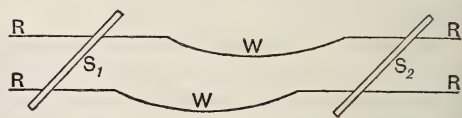
In this formula the strength of field is given in lines per square centimetre and speed and length are given in centimetres.

The mechanical force experienced by a conductor in the neighbourhood of a magnet pole is, according to our modern views, due to the fact that the conductor is laid across the lines of force emanating from the magnet pole. The force in dynes is given by the product, $H c l$, c being the current. Since there are 981,000 dynes required to represent the force of one kilogramme, and since the C.G.S. unit of current is 10 amperes, we have the force produced by a current of c amperes—

$$\text{Kilogrammes} = \frac{H c l}{9,810,000}$$

These are the two fundamental equations required in the design of plant for the electric transmission of power. Now let us see what is the most simple kind of plant we could possibly employ. At the generating station we require a conductor cutting lines of force; this conductor must be joined by wires with a similar conductor at the receiving station. The second conductor is also laid across lines of force, so that when a current passes it will be acted upon by a mechanical force displacing it parallel to itself and doing work. The arrangement here described is shown in Fig. 1, where the lines R represent

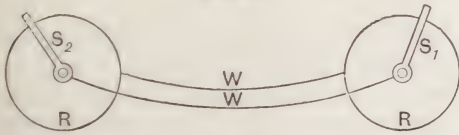
FIG. 1.



fixed, horizontal, parallel rails, across which are laid sliding rails or sliders, S_1 S_2 . Imagine the magnetic lines of force passing vertically between the fixed rails, then, if we displace the slider S_1 , an electromotive force will be set up in it, causing a current to flow through the connecting wires, W , and the slider S_2 at the receiving station. The slider S_2 is supposed to be laid across lines of force, and will, therefore, be acted upon by a mechanical force. Thus, power may be electrically transmitted from the slider S_1 to the slider S_2 . It will immediately occur to you that the experiment I have here illustrated could easily be tried by means of any

railway. The fixed conductors and connecting wires would be the rails; the generating slider would be a crowbar thrown across them, and hauled along by a train; and the lines of force would be supplied by the vertical component of terrestrial magnetism. At another part of the railway—possibly miles away—another crowbar thrown across the rails should then be set in motion, by the current passing through it. Theoretically, such an arrangement represents correctly enough the electric transmission of power; but, I need hardly tell you that it would not work in practice. If you apply the E.M.F. formula I have given to this case, you will find that, even if the slider is hauled along at the speed of an express train, there will only be generated about the one-thousandth part of a volt, the reason being that the magnetic field provided for us by nature is so extremely weak. If we could apply an artificial magnetic field of the strength generally employed in dynamo machines—that is, about 10,000 times as strong as the vertical component of terrestrial magnetism—then we could get about 10 volts in our slider. Now, it is obvious that we can not spread so strong a field over miles of railway; and we must, therefore, alter our arrangement. This may be done as indicated in Fig. 2, where one of the rails has been re-

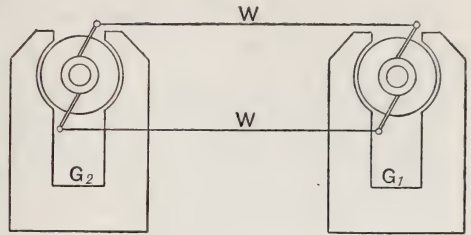
FIG. 2.



placed by a centre contact, and the other by a circular conductor. The slider, instead of being moved parallel to itself, must now revolve round the centre contact, which can easily be done by a belt and pulley. We have thus arrived at what is known as a non-polar dynamo. But even this arrangement, although very much better than the progressive slider, is not of practical value for power transmission, because the E.M.F. of non-polar dynamos is still too low. It is only a few volts, whereas we require hundreds, or even thousands, of volts to carry the current to any distance. The obvious remedy is to use a large number of revolving sliders, so connected that the E.M.F. generated in each shall be added; in other words, instead of a non-polar dynamo,

we must use an ordinary continuous current dynamo, wound for high E.M.F. This arrangement is shown in Fig. 3, where G_1 is the

FIG. 3.



generator and G_2 the motor or receiving dynamo. If you connect their brushes, as shown in the diagram, and rotate the armature of the generator, a current flows through it, the line wires W , and through the armature of the motor, and exerts upon the latter a mechanical force, tending to produce rotation and give off mechanical power. I am able to show you this experimentally, by means of two dynamos connected, as shown in Fig. 3.

THE MACHINES EMPLOYED IN POWER TRANSMISSION.

This experiment has shown how power may be transmitted electrically. Let us now consider somewhat more in detail the different parts of the transmitting plant. At one end of the line of transmission we have the generating dynamo, at the other we have the motor dynamo, and then we have the line itself, consisting of two wires insulated from each other and from earth. You will readily see that although for the convenience of experimental illustration I have placed the generator and motor close together, this proximity was not an essential condition of the experiment. The motor might have been placed in another room, or in a different part of London, and still the experiment would have succeeded, provided I had used sufficiently stout and well-insulated connecting wires. But then you could not have had ocular demonstration of the fact that movement of the generator armature is closely followed by a corresponding movement of the motor armature.

A full treatment of my subject would of course include a complete investigation of the dynamo, but this I shall not attempt. In the first place there is no time for it, and in the

second place it is hardly necessary, since you are all more or less acquainted with these machines. I shall therefore not occupy time

by giving mathematical proofs for the few formulæ I shall have to use, but assume that they are familiar to you. They are as follows:—

$$\begin{aligned}\text{Volts} & \dots\dots\dots = H v l 10^{-8} \\ \text{Kilogrammes} & = \frac{H c l}{9,810,000}\end{aligned}$$

C Total current through armature; c , current through single armature conductor.

e_a E.M.F. in armature in volts.

τ Number of active conductors counted all round armature.

p Number of pairs of poles ($p = 1$ in a two-pole machine.)

n Speed in revolutions per minute.

F Total induction in C.G.S. lines.

Z „ „ English lines.

$$\begin{aligned}\text{Electromotive force} & \left\{ \begin{aligned} e_a &= F \tau \frac{n}{60} 10^{-8} \\ e_a &= Z \tau n 10^{-6} \end{aligned} \right\} \text{for two-pole machines.} \\ & \left\{ \begin{aligned} e_a &= p F \tau \frac{n}{60} 10^{-1} \\ e_a &= p Z \tau n 10^{-6} \end{aligned} \right\} \text{for multipolar machines with series wound armature.} \\ \text{Torque} & \dots\dots \left\{ \begin{aligned} \text{Kilogramme-metres} &= 1.615 F \tau C 10^{-10} \\ \text{Foot-pounds} &\dots\dots = 7.05 Z \tau C 10^{-6} \end{aligned} \right\} \text{for two-pole machines.} \\ & \left\{ \begin{aligned} \text{Kilogramme-metres} &= 3.23 F \tau c p 10^{-10} \\ \text{Foot-pounds} &\dots\dots = 14.10 Z \tau c p 10^{-6} \end{aligned} \right\} \text{for multipolar machines.}\end{aligned}$$

In analysing these formulæ you will observe a curious parallelism. The symbols for field strength and total number of active armature wires occur in either group, but the current occurs only in the group giving torque, or mechanical turning effort, and the speed occurs only in the group giving E.M.F. Now if you multiply any of the torque formulæ with the speed you get on the left—mechanical power; and on the right the product of electromotive force, multiplied with current and a constant, or, in other words, electrical power; by working this out in figures, you will find that mechanical energy expressed in horsepower is equal to watts divided by 746, the well-known equation for converting mechanical into electric power.

The formulæ are equally applicable to cylinder armatures wound gramme fashion and to drum armatures, provided we count not turns of wire but active conductors over the whole circumference of the armature. As regards two pole machines, the formulæ are the same

as found in every text-book on dynamos, but as regards multipolar machines, a little explanation is required, both as to the winding and as to the advantage or otherwise of using more than one pair of poles. To make the explanation clear I must refer for a moment to the ordinary method of drum winding for two pole armatures. When such a winding is illustrated in a text-book, the author takes care to show only very few conductors, for the simple reason that the diagram would be one unintelligible maze of lines if it were drawn so as to represent an armature as really made. To get over this difficulty I employ, instead of a diagram, a tabular statement of the winding such as you see on the wall. This particular Table represents the winding of a drum armature having 100 active conductors.

The figures at the top of the vertical columns indicate the direction of winding, supposing the winder looks at the armature end on. The letter D signifies a wire, wound down or away from him; and the letter U, a wire wound up

DRUM WINDING.

F	B	F	B	F	B	F	B	F	B	F
D	U	D	U	D	U	D	U	D	U	D
100	49-98	47	96	45	94	43	92	41		
90	39	88	37	86	35	84	33	82	31	
80	29	78	27	76	25	74	23	72	21	
70	19	68	17	66	15	64	13	62	11	
60	9	58	7	56	5	54	3	52	1	
50	99+48	97	46	95	44	93	42	91		
40	89	38	87	36	85	34	83	32	81	
30	79	28	77	26	75	24	73	22	71	
20	69	18	67	16	65	14	63	12	61	
10	59	8	57	6	55	4	53	2	51	
100	49-98									

or towards him. The letters F and B, placed between the others, denote the front and back connections respectively. In modern machines these connections are not made of flexible wire, but are separate pieces, specially made to shape, and are generally of larger section than the conductor, so as to reduce the resistance of the armature as much as possible. One form of connector is on the

TABLE OF WINDING FOR 8-POLE DRUM ARMATURE; 202 CONDUCTORS; SERIES WINDING; BRUSHES (\pm) 135° APART.

F	B	F	B	F	B	F	B	F
D	U	D	U	D	U	D	U	D
202	25	50	75	100	125	150	175	
200	23	48	73	98	123	148	173	
198	21	46	71	96	121	146	171	
196	19	44	69	94	119	144	169	
194	17	42	67	92	117	142	167	
192	15	40	65	90	115	140	165	
190	13	38	63	88	113	138	163	
188	11	36	61	86	111	136	161	
186	9	34	59	84	109	134	159	
184	7	32	57	82	107	132	157	
182	5	30	55	80	105	130	155	
180	3	28	53	78	103	128	153	
178	1	26	51	76	101	126	151	
176	201	24	49	74	99	124	149	
174	199	22	47	72	97	122	147	
172	197	20	45	70	95 +	120	145	
170	195	18	43	68	93	118	143	
168	193	16	41	66	91	116	141	
166	191	14	39	64	89	114	139	
164	189	12	37	62	87	112	137	
162	187	10	35	60	85	110	135	
160	185	8	33	58	83	108	133	
158	183	6	31	56	81	106	131	
156	181	4	29	54	79	104	129	
154	179	2	27	52	77	102	127	
152	177	202						

table, both in pieces and built up. By referring to the winding-table, you will see that every wire is numbered; and thus we can see at a glance how the ends of each wire are connected. The Table on the wall refers to a two-pole machine; that on the slip in your hands, to an eight-pole machine, wound so as to obtain the E.M.F. of the four pairs of poles in series. The printed Table, giving the eight-pole winding, is almost self-explanatory; but, to assist you in understanding the winding of these multipolar machines generally, I had this model prepared, showing a few of the conductors of a six-pole armature. This method of winding has been invented by Messrs. Scott & Paris: patents 4683 and 6261, of 1874. There are no internal cross-connections, the ends of the conductors being joined simply by connecting segments of the kind I have just shown you, but with this difference, that each segment, instead of embracing half a circle, embraces only one-sixth of a circle. The winding goes in zig-zag, so to speak, round the armature, returning to the second wire in front or behind the previous starting point. There are thus only two brushes required. The winding-tables show, also, very clearly how the E.M.F. increases from wire to wire, and that the greatest difference of potential occurs between neighbouring wires at the diameter of commutation. The difference of potential between neighbouring connector segments is, however, limited to the E.M.F. due to the two conductors. The winding is used for machines intended to give high-pressure currents, such as are required in power transmission. When low-pressure and large currents are required, the winding is altered, so as to form overlapping loops on the armature, and for intermediate electromotive forces a combination of both methods can be used. But as these windings have no immediate importance for power-transmission, I shall not detain you with a description of them.

Now, as to the advantage of multipolar machines, such as the one which I illustrated on the screen. The field magnets are arranged perfectly symmetrical round the armature; and thus the one-sided magnetic pull, consequent upon the employment of a single pair of horse-shoe magnets, is avoided. There is very little magnetic leakage, the machine being what is known as iron-clad; and, as I have already shown, the E.M.F. is equivalent to that of several smaller machines, coupled in series. The internal diameter of the armature

is very large, affording plenty of space for the ingress and egress of air; and the weight of the machine is less than that of an equivalent two-pole machine. The most important advantage, however, is the small armature reaction. Experience with large two-pole machines has shown that there is a limit to the size above which such machines are satisfactory. This limit depends, of course, on the speed and voltage, as well as on the output; but, roughly speaking, we may take it that, for moderately high voltage, and an output above 100 horse-power, the multipolar machine is preferable; and we find, accordingly, that, for the transmission of large powers multipolar machines are, as a rule, employed.

I have hitherto not made any distinction between motors and generators, because the difference between them is almost negligible. There are certain secondary effects, which may be a little greater in one machine than in the other; but these are of so little importance, that it will not be worth while to devote any time to their consideration. As a rule a good generator makes a good motor. All we require to do is to set the brushes a little forward of the neutral line in the former, and a little back from that line in the latter. Now let us see what it is we must naturally aim at in putting up a transmission plant. At the generating end of the line we want as high an E.M.F. as we can get, because a high E.M.F. means large power and small per-centage loss due to line resistance. At the motor end we want as large a torque or statical effort as possible, combined with a certain speed. But a glance at the formulæ will show that it is impossible to get speed without also getting E.M.F., which, in the case of the motor, must oppose the current, and thus the current actually flowing through the motor is that due to the difference between the E.M.F. of the generator and the counter E.M.F. of the motor. This difference divided by the total resistance of the circuit gives the current.

The electrical power developed in the generator is the product of this current, and the E.M.F. in its armature. The electrical power converted by the motor is the product of the same current and the counter E.M.F. of its armature. It therefore follows that the electrical efficiency of the whole system is given by the ratio between the generator and motor E.M.F. The more nearly alike these two are, that is to say, the less E.M.F. lost in resistance, the greater will be the electric efficiency.

Now the smaller the current the less E.M.F. is lost in resistance, but to get power with a small current we must work at high pressure, and we thus find that from the point of view of electrical efficiency only, the higher the voltage the better. There are, however, other things to be considered besides electrical efficiency, and if we take due account of these we find that for every case there is one particular voltage at which it is best to work.

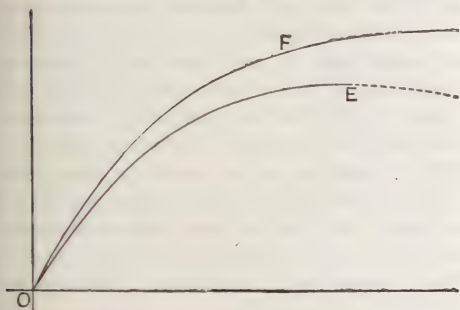
Upon this subject I shall enter presently, but before doing so I must place before you some points in connection with the regulation of speed and power in transmission plants. Unless we can control the speed and regulate the power given out at the receiving end of the line, the most perfect motor or the most efficient system is useless. Fortunately, however, electricity is not only a powerful transmitting agent, but also one that can be easily controlled, and my next task is to show you how this control is effected.

What we generally desire to get in practice is a constant speed of the motor, whatever may be the mechanical power taken out of it at any moment. This condition is the same as that required from a good steam-engine or other well-governed prime-mover. The construction of the motor to comply with this requirement depends, of course, on the condition of supply. We can imagine a large variety of cases, but from a practical point of view I need only consider two, namely supply at constant pressure such as we get, or ought to get, from mains connected with a central electric-light station, and supply of current at constant or variable pressure from a generator erected specially for the purpose, the regulation of current and pressure being automatic. The latter case is that more particularly met with in long distance transmission of large powers, the former is a case referring rather to the distribution of small parcels of power over short distances from a central station. I will take this first.

We have, then, these supply conditions—pressure at the terminals of the motor constant, current variable, according to the call for power. Let (in the diagram Fig. 4) the curve *F* represent the characteristic of magnetisation of an electromotor, that is, a curve obtained by plotting ampere-turns of exciting power on the horizontal and total field strength (denoted in the formulæ by *F* or *Z*) on the vertical. If the motor is series-wound you see that the larger the current the stronger will be its field, and

by referring to the E.M.F. formula you will find that if the speed is to remain constant the counter E.M.F. must increase in the same ratio as the field strength increases. But the counter E.M.F. must under all circumstances be smaller than the supply E.M.F. by just the amount required to overcome the resistance of the circuit through the motor, and this difference is of course proportional to the current. To satisfy the supply condition the counter E.M.F. of the motor ought to slightly decrease as the load and with it the current increases, then the speed will keep constant. But this is exactly the opposite of what the motor requires. Say the machine is running at a certain speed, and giving out a certain amount of mechanical power. Now increase the load. The immediate consequence will be that the speed is slightly decreased, the counter E.M.F. is slightly decreased, and the current is increased. This will immediately strengthen the field and thus raise the counter E.M.F. again;

FIG. 4.



this will check the current, produce a further drop in speed, and so the reaction will go on until a new stable condition of working is reached at a larger current and lower speed. If we take the load off the same reaction takes place, only in the opposite sense, and the speed may become dangerously high. What I have here described happens of course only if the machine is worked on the rising part of the E.M.F. characteristic E, the part which we would naturally select for economical working. If we over-excite the field magnets, that is if we employ a great deal more field wire than necessary, then we can work the machine on the drooping part of the characteristic shown by a dotted line in the diagram and obtain approximately constant speed between certain limits, but the machine will still be liable to race as soon as we throw the load off completely. We thus find that a series-wound motor is certainly not suitable for our purpose.

Let us now inquire whether we shall be any

better off with a shunt-wound motor. The field excitation in such a machine does not depend on the current flowing through the armature as in a series machine, but it is simply the result of the terminal pressure, in other words, whatever current may be required by the armature for giving power, can be and is in fact supplied by the source of current, without in any way affecting the field excitation. If the terminal pressure varies the excitation and the field strength must also vary, but a variation in the working current will not directly influence the field strength. It will, however, indirectly influence it by reason of a subsidiary effect technically termed "armature reaction," and this I shall touch upon shortly. For the present we neglect it, and assume that the curve F correctly represents the field strength as a function of the terminal pressure. In machines having wrought-iron magnets the first part of this curve is almost a straight line, and in this region the field strength is consequently very nearly in direct proportion to the terminal E.M.F. To work the motor at this part of its curve all we have to do is to supply it with current at a pressure sensibly lower than that for which it is designed. In good machines the resistance of the armature is very low, so that only a few per cent. of the voltage supplied is lost in resistance, even when the maximum current flows through the armature. If, therefore, we work the motor considerably under its power, the armature loss will be almost negligible, that is to say, the counter E.M.F. will be very nearly equal to the supply E.M.F. Now if you look at the formula for E.M.F., you find that on the left you have a value very nearly equal to the supply E.M.F., and on the right you have a constant multiplied with the product—field strength and speed. But the field strength under our special conditions of working is proportional to the supply E.M.F., and as you thus have the supply E.M.F. on both sides of the equation, it cancels out, and you find that the speed, multiplied by a constant, is equal to unity. This of course holds good for any supply E.M.F. within the straight part of the curve; and we find, therefore, that the speed has a definite value which is independent of the supply E.M.F. We have here arrived at a very remarkable result. It is this, that if you work a shunt-motor underloaded and at a lower pressure than it is designed for, you may vary this pressure within certain limits without either altering the speed or the power given out.

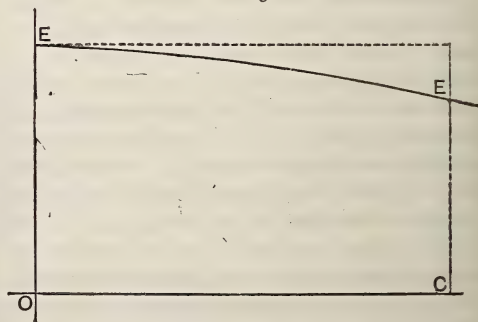
As, however, the motor must be large in proportion to its work, the practical use of this remarkable property of shunt-motors is limited. What users of these machines want to do is not to get little power out of them, but to get as much power as possible, and, in many cases, more than was intended by the designer. Let us, then, see how we stand in the matter of speed and power regulation when we work the machine throughout the whole range of output for which it is designed. First as to speed. Let us assume that the machine is working at a certain speed giving off a definite amount of power, and suppose we wish to increase the speed. How shall we do it? The E.M.F. formula tells us. You see that field strength and speed occur on the same side of the equation. This means that the one can only be increased at the expense of the other. If we want the machine to run faster we must weaken its field, if we want it to run slower we must strengthen it. The variation of field strength is most conveniently brought about by a variable resistance in the magnet circuit. I have such a resistance in the shunt circuit of the machine before you, and can show you, by an experiment, this method of regulating the speed.

In this experiment we have altered both the speed and power, because, by running faster, we have obtained more current from the second machine and a brighter light in the lamp. Let us now see whether it is possible to keep the speed constant, and yet vary the power. Bearing in mind that the dynamo is a reversible machine, and drawing a parallel between a shunt-dynamo and a shunt-motor, we conclude that there should be no difficulty in doing this. The fact that a shunt-motor is an almost self-regulating machine has been first pointed out by Mr. Mordey in an article which appeared in January, 1886, in the *Philosophical Magazine*. Mr. Mordey's reasoning was somewhat as follows:—We know that a shunt-dynamo will, if driven at a constant speed, give an almost constant terminal pressure, no matter how the current may vary. Consequently, a shunt-motor, if supplied with current at constant pressure, will run at an almost constant speed, no matter how the load may vary. On testing his theoretical deduction by actual experiment, Mr. Mordey was able to completely verify it. In one set of experiments the supply current was kept at 140 volts, and the load on the motor was varied from 1·8 to 16·3 horse-power, yet the speed only varied by 3 per cent.; and a

similar result was obtained with the same machine at a supply pressure of 100 volts. Mr. Mordey stated in his paper that the magnetic distortion of the field was nil, or, as we might also term it, that the armature reaction was negligible. It is, however, easy to see that, even if the armature reaction is sensible, we can yet obtain very fair regulation, provided we take care to have in the armature circuit such a resistance that the voltage loss due to the resistance is about equal to that due to armature reaction.

To explain this, I must first say a few words about armature reaction, a phenomenon which may perhaps not be familiar to all of you. The current, flowing through the armature, transforms it into an electro-magnet, which, to a certain extent, opposes the flow of magnetic lines emanating from the field magnets. This is the case, both in dynamos and motors, though not quite to the same extent. The larger the current, the larger is this opposition which the armature offers to the field magnets; and it is the field strength which remains, after making allowance for this opposing magnetic force, which is productive of electromotive force. To calculate correctly the counter E.M.F. of a shunt-motor, we must, therefore, not assume the field strength in our E.M.F. equation to be constant, as I have done hitherto; but we must assume that it decreases slightly as the armature current increases. Graphically, this is represented in Fig. 5, where the current flowing through the

FIG. 5.



armature is measured on the horizontal OC , and the field strength is represented by the inclined full line above. If there were no armature reaction the field strength would be given by the dotted horizontal line. If the speed is to remain constant, the counter E.M.F. must be proportional to the field strength; and, by suitably altering the scale (with which we measure the ordinates in the

diagram), we can take the top line to represent counter E.M.F. I have accordingly marked it *EE*.

The vertical distance, *OE*, represents now the supply E.M.F.; and, when the motor is running light, this is, of course, equal to the counter E.M.F. Now, let a load be thrown on, causing a considerable increase of current. The counter E.M.F. need now not be quite so large as before, since part of the supply E.M.F. has been already absorbed by the resistance of the armature circuit, and the counter E.M.F. need only balance the remainder. We find thus, that the supply condition of constant voltage requires the counter E.M.F. to become lower, as the power demanded from the motor increases. At the same time, the working condition of constant speed can only be attained by a lowering of the counter E.M.F. as the current increases; and it is, therefore, perfectly obvious that, if the lowering of the counter E.M.F., as determined by either condition, is the same, we must have constant speed at variable power—that is, a self-regulating motor. Generally, the line *EE* in the diagram representing counter E.M.F. is not quite straight, but slightly curved, presenting the concave side to the axis of abscissæ; whilst the line representing resistance loss through armature is, of course, quite straight. If we so design the machine as to get exactly the same speed, when running quite light and fully loaded, the speed will be slightly less at half-load, but the difference can only be very small. I am able to show you this property of the shunt-motor to be almost perfectly self-regulating, by means of the apparatus here before you.

Thus, you see, that the shunt-motor is an excellent machine for keeping the speed constant, when worked on a constant-pressure circuit. The only drawback to its employment is, that a resistance must be inserted into the armature circuit at starting; but this may be done automatically, by placing the resistance permanently in circuit, and causing it to be short circuited by means of a centrifugal regulator fixed to the armature shaft, and so arranged that when the speed has attained a certain value the balls fly out and close a switch. Such an automatic device is also of value in case the motor should be overloaded. If this should happen the speed will drop, and the resistance will be automatically re-inserted, keeping the current within safe limits. By these means a customer of an electric light company is prevented from taking

from the mains more current than he has contracted for.

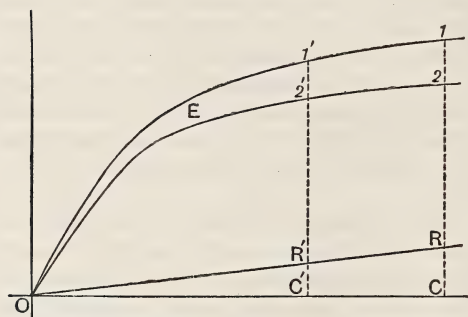
Before leaving the subject of speed regulation on constant pressure circuits, I must briefly allude to a system in use on electric tramways. Motors for tram-cars are not required to run at a constant speed, but they are required to have a wide range of torque. At starting, or when running up hill, the speed may be low, but the static effort must be great. These motors are therefore generally series-wound, and provision is made by means of a compound switch for inserting a larger or smaller number of field magnet coils, so as to vary the field strength according to requirements. The arrangement of the motors under the floor of the car is shown in the diagrams on the wall, which represent respectively the cars of Mr. Reckenzaun, the Electrical Engineering Company, and the General Electric Power and Traction Company, but time will not permit of my going into the details of the various designs.

When current is supplied to the motor not from a general system of mains, but from a special generator, serving no other purpose, the regulation of speed and power can be effected equally well by series, compound, or shunt machines. As regards the latter, I need not go into details, as this case is really included in the case of supply at constant pressure which I have already fully treated. After what I have said about this case, you will also readily see that compound wound motors with the main coils demagnetising are equivalent to shunt-motors with large armature reaction, and that in fact a shunt-motor with very small armature reaction, such for instance as a multipolar machine, may be made self-regulating by the addition of demagnetising main coils on the field magnets. I shall later on give you details of a large transmission plant carried out on these lines, and need therefore not go further into the subject now. There remains then only the plain series motor to be considered.

In this case both the generating and the receiving dynamo are series wound, and it is easy to see that by suitably designing these machines we can bring it about that the motor will run at a constant speed under varying loads if the generator is kept running at a constant speed at all times. Let the two curves in Fig. 6 represent the E.M.F. characteristics of the two machines, the upper curve referring to the generator and the lower to the motor. These curves give the useful E.M.F. after deducting

armature reaction, and refer of course to constant speed in each case. The current flowing through the circuit is that which we obtain by dividing the difference between the ordinates of the two curves by the total resistance. The resistance is of course a constant and the curve representing current and difference of E.M.F. is therefore a straight line, OR in the diagram. The vertical length, CR , gives the voltage loss with a current, OC , due to resistance, and this must be equal to the voltage difference, $1, 2$, between the curves. This determines therefore the speed of the motor for that particular current. Suppose the lower

FIG. 6.



curve is the E.M.F. characteristic for that particular speed. Now let us throw some of the load off, then the current will assume a smaller value, say OC' . The voltage loss is now $C'R'$, and the voltage difference $1'2'$. If the E.M.F. characteristic fits this new working condition, then $1'2'$ must be equal to $C'R'$, and the speed will remain the same as before. We thus find that if we so design the machines that the difference between their E.M.F. characteristics at any working point is equal to the voltage loss by resistance, we obtain a perfectly self-regulating system of power transmission. Most of the transmissions now at work have been designed by taking advantage of this very valuable quality of series machines, but I must state at once that, in actual practice, the case is not quite so simple as I have here represented it. One of the difficulties met with is that we cannot always get the two characteristics to fit each other exactly over the whole range of output; another difficulty arises from there being generally a slight difference between the ascending and descending characteristics; but the most serious obstacle to quick and perfect regulation is the self-induction of the field magnets, especially if the machines are large. The self-induction prevents the rapid response of one machine to the other, which is required to make the regu-

lation absolutely perfect. A sudden change of load cannot be followed immediately by a corresponding change in the power supplied to the motor, as time is required by the magnets to settle down into the new working condition; and during the transitory period, which may last many seconds, there is a surging of power to and fro which creates fluctuation of speed. To mitigate this evil, Herr Dobrovolsky, of the Berlin Electric Company, has devised a plan by which a kind of electrical damper is applied to the generator in the shape of a non-inductive high resistance placed across the terminals of the magnet coils as a shunt, and left there permanently. Any abnormal wave of E.M.F. which might otherwise disturb the working of the motor or endanger the insulation of either machine, spends itself in heating this resistance, and the disturbance quickly subsides.

THE LINE.

I pass now to the consideration of the line, a subject of great importance, especially in long distance transmission, since in these cases the cost of the line forms a very large item in the total cost of plant. You are all familiar with Sir William Thomson's law for greatest economy in conductors. Briefly, the reasoning on which this law has been developed is as follows. The annual cost of power delivered is made up of two items. First, the cost of the power only, and secondly, the interest on the capital outlay. The cost of power includes that amount which is wasted in heating the conductor. If I, therefore, wish to work with the greatest economy, the sum of annual interest on the capital outlay and cost of power wasted must be a minimum; and this condition is attained when the two are equal. Professors Ayrton and Perry were the first to question the practical applicability of this law. In a paper read by them before the Institution of Electrical Engineers in March, 1888, they showed that, under certain conditions, better economy can be obtained by departing from, instead of following, Sir William Thomson's law. I do not propose to give you quotations from their paper, which is highly mathematical, but I will endeavour to put the subject before you in a different way, requiring only very little mathematical treatment.

First of all, let us see, in a general way, what Sir William Thomson's law really means. It supposes that the annual electrical horse-

MOST ECONOMICAL CURRENT FOR ELECTRIC POWER TRANSMISSION.

D	Distance in miles.
a	Section of conductor in square inches.
E	Terminal volts at generator.
e	Terminal volts at motor.
HP _g	Brake horse-power required to drive generator.
HP _m	Brake horse-power obtained from motor.
c	Current in amperes.
	Efficiency of generator 90 per cent. ; efficiency of motor 90 per cent.
g	Cost in £ per electrical horse-power output of generator.
m	Cost in £ per brake horse-power output of motor including regulating gear.
G = .9g HP _g	Cost in £ of generator.
M = m HP _m	Cost in £ of motor and regulating gear.
t = 18.2 Da	Weight in tons of copper in line.
K	Cost in £ per ton of copper, including labour in erection.
s	Cost in £ of supports of line per mile run.
p	Cost in £ of one annual brake horse-power absorbed by generator.
q	Per-centage for interest and depreciation on the whole plant.

$$\text{Capital outlay} = g \frac{Ec}{746} + m \text{HP}_m + Ds + \frac{1.6 K D^2 c^2}{Ec - 830 \text{HP}_m} = A.$$

$$\text{Annual cost per brake horse-power delivered} = q \frac{A}{\text{HP}_m} + p \frac{\text{HP}_g}{\text{HP}_m}.$$

$$\text{Put } B = \frac{E p}{670} + q \frac{E g}{746}.$$

$$\gamma = \frac{830}{E} \text{HP}_m, \text{ the current which would be required if the line had no resistance,}$$

$$\text{and } \beta = \gamma^2 \frac{E B}{1.6 q K D^2 + E B}; \text{ then the most economical current at the given voltage } E \text{ is}$$

$$c = \gamma \left(1 + \sqrt{1 - \frac{\beta}{\gamma^2}} \right)$$

$$c = \gamma \left(1 + \sqrt{\frac{1.6 q K D^2}{1.6 q K D^2 + E B}} \right)$$

For very long distances the term under the square root approaches unity and the most economical current the value 2γ ; from which it follows that under no circumstances will it be economical to lose more than half the total power in the line.

power has a definite value at any place reached by the conductor. This is generally assumed for the distributing system as carried out from central stations. Whether a customer lives 100 yards or 500 yards from a central station, the company charges him the same for the current. But the assumption is not, strictly speaking, correct. To see this, let us suppose that the cost to the company of putting an annual horse-power into their mains is £20, and they get £30 for every annual horse-power taken by the customer. Now, if I lose 1 horse-power, shall I be right in writing off this loss at £20? Clearly not; for if I had not lost this particular horse-power, I might have sold it for £30. But there is another way of looking at this. You might say that the £10 difference between the cost and selling price of

power represents profit and interest of plant and mains, and that, therefore, the lost power should be debited at net cost. To this I reply, that my object is not to put power into the mains, but to take power out, or, rather, enable my customers to take power out, for which they will pay me; and so we might keep arguing the question, without ever coming to a definite understanding. Now, if we cannot settle such a simple problem by common-sense reasoning, there must be something wrong in our premises; and, in this case, it is not difficult to see where the hitch is. It is in the assumption that the power has a constant value. In reality, this is never the case. If it were the case—that is to say, if one horse-power had the same value at the motor end as it has at the generator end of the line—it

would be perfectly useless to establish a transmission plant: it would be like carrying coals from Cardiff to Newcastle. It is only because the power has a great value at the motor end of the line, and a small value at the generator end, that it will pay us to lay out capital in plant, and incur the risk of working it.

The correct way of treating this problem is, therefore, to take into account the cost of the power, both at the generating and at the receiving station. We must, further, take into account not only the interest and depreciation of the line, but also the interest and depreciation of the machinery at either end; and, in estimating these items, we must know at what voltage the plant is to work, and what total power is required; for the prime cost per horse-power depends very materially on the total power and voltage. To make this clear: if I want to reduce the capital outlay on the line, I must work at high voltage, and with a large energy loss. This means, that I must put down a larger generator than would otherwise be required, and, moreover, one that gives a high-pressure current. It is thus quite possible that, what I save in the line, I shall have to expend at the generating station, to say nothing of the increased charge for waste power, and the greater liability to have a breakdown, owing to high voltage.

You see this problem is a very complicated one; and Thomson's law, which says nothing about voltage or cost of machines, will not fit it. It is, however, possible to amend this law, so as to obtain at least an approximate solution. The premises on which the formula has been deduced are as follows:—

Conditions given.—Annual value of brake horse-power at generating station; voltage at generator terminals; brake horse-power required at motor end; distance of transmission; cost per horse-power of machines and regulating appliances at the given output, and voltage; cost of conductor, per ton of copper erected, interest, and depreciation of whole plant.

Data required.—Working current, brake horse-power at generating station, mechanical efficiency, voltage at motor, total capital outlay per brake horse-power delivered, and cost of annual brake horse-power.

The efficiency of each machine is assumed to be 90 per cent. The formula gives only the current, but the other data can be found by very simple calculations which need no explanation. The cost of supports for the line per mile, whether overhead or underground,

can be taken as constant, that is, not depending on the exact current within the limits, which can easily be foreseen in each case; and it therefore does not enter into the formula for the current. Interest and depreciation I have taken the same for all parts of the plant, so as to avoid too great a complication of the formula. If you now work out by the aid of the current formula the same transmission problem for different voltages, you will find that there is one particular voltage for which the annual cost of the brake horse-power delivered at the motor end of the line is a minimum; and, provided this voltage is within reasonable limits, it ought to be adopted. When making such calculations, you will find that the greater the cost of power at the generating station, the higher is the most economical voltage, this voltage also, of course, increasing with the distance.

Each case must be worked out with due regard to local conditions, and nothing in the shape of cut and dried rules or figures can make this work superfluous. On the other hand, it is very desirable to collect information as to the cost of works which have actually been carried out, and by the liberality of Mr. Brown, the engineer to the Oerlikon Works, Switzerland, I am able to place before you some figures of this kind which are contained in the following Table. The figures give the whole capital outlay for the electrical parts of some of the power transmissions erected by this firm.

COST OF TRANSMISSION OF POWER PLANT.

Distance in Miles.	HP Delivered	Speed of Machines	Cost in £			Total Cost.*	Cost per HP.
			Gen.	Mot.	Line.	£	£
1'870	85	450	640	560	440	1,880	22'2
'280	195	500	760	680	132	1,800	9'7
'280	51	600	320	280	60	720	14'1
'375	90	550	520	480	80	1,240	13'8
'560	71	600	440	400	60	1,040	14'6
'280	40	700	260	240	20	640	16
'375	75	600	480	440	68	1,120	15
'500	87	500	520	480	100	1,260	14'5
1'560	150	600	760	720	330	2,050	13'7
'220	93	450	440	420	232	1,270	13'7
6'250	11	900	132	110	480	960	87
2'200	51	600	360	320	300	1,140	22'4
'187	60	900	240	220	18	600	10
5'000	41	750	240	200	344	1,020	24'8
3'750	220	600	1,040	960	640	2,960	13'5
'062	15	600	112	104	8	252	16'8
'250	19	700	160	160	20	390	20'5

* This includes regulating apparatus, instruments, posts, insulators, lightning arresters, erection, and supervision.

Journal of the Society of Arts.

No. 2,017. VOL. XXXIX.

FRIDAY, JULY 17, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CHICAGO EXHIBITION, 1893.

The Attorney-General, as Chairman of the Council, has received a communication from the Foreign-office, expressing the desire of Her Majesty's Government to nominate the Council of the Society of Arts a Royal Commission for the British Section at Chicago, and its intention of placing at the disposal of the Royal Commission a sum of £25,000, to defray its expenses.

The Council have expressed their readiness to undertake the duty, and are now engaged in the preliminary arrangements necessary to carry it out.

As soon as possible full information will be distributed to intending exhibitors. In the meantime, any applications in connection with the British Section may be addressed to the Secretary of the Society of Arts, Adelphi, London, W.C.

HENRY TRUEMAN WOOD,
Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE ELECTRIC TRANSMISSION OF POWER.

BY GISBERT KAPP.

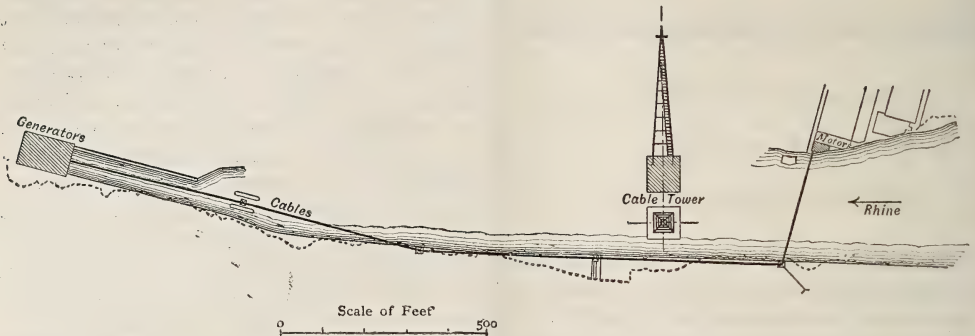
Lecture III.—Delivered March 2, 1891.

As an example of a large modern transmission plant, I select, for illustration, that erected a few months ago for the Schaffhausen

Spinning Mills. This example is not only interesting on account of its magnitude, but because it has been planted, so to say, into the very stronghold of rope transmission, namely, at the Falls of the Rhine, where the last generation of Swiss engineers carried out such admirable work in teledynamic transmission, that the present generation can only copy, but cannot improve upon it. And the grand example set by Redtenbacher, Amsler, and others, on the Rhine has, as a matter of fact, been largely copied at other places. There is hardly a large engineering works in Switzerland or the South of Germany where rope transmission in some form or other will not be found, but the best days of this system are passed. Till recently, rope transmission held the field absolutely, not because it was perfect, but because there was nothing better. Now, however, we have something better in electric transmission, and the flying ropes are being steadily replaced by the electric conductors. In the first place, the capacity of teledynamic transmission to deal with large powers is limited. During last year, the Niagara Commission inspected a large number of plants in Europe, and came to the conclusion that 330 horse-power is the very utmost which can be dealt with by a single rope, so that above this power we must employ more ropes with a corresponding complication in the gear. I need hardly say that no such limit exists in electric transmission. But there are other difficulties in connection with ropes. They wear out very fast, their support at the translating stations on the line requires the erection of very heavy and costly structures, and they are largely influenced by climatic changes, causing excessive strains at some times, and slipping at others. These considerations have induced the managers of the Schaffhausen Spinning Mills to adopt electric transmission in the very spot where rope transmission, in years gone by, has received its most perfect development possible.

The situation of the works is shown on the diagram (Fig. 1). The spinning mills are on one side, and the generating station is on the other side of the river, the distance between the two being about 750 yards. In the generating station there is room for five 350 horse-power turbines, of which four are now in place, but of these only two are as yet used in connection with the electric power transmission I am about to describe. The power of these turbines is sold to the Spinning Company at the rate of £2 16s. per annual

FIG. 1.

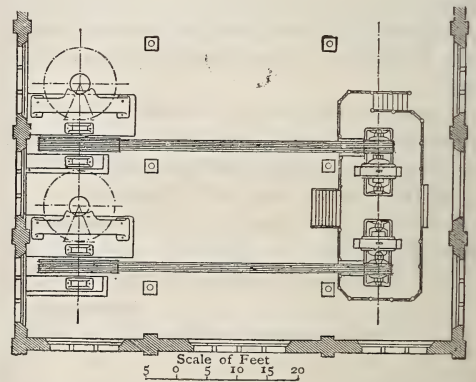
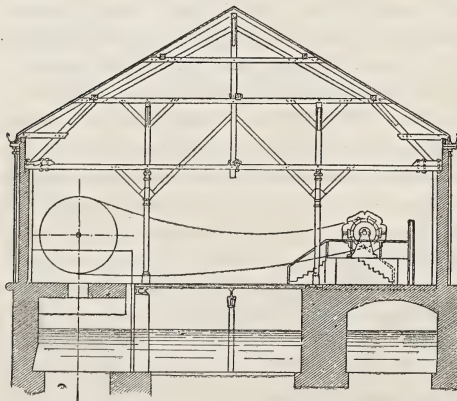


horse-power taken off the rope pulleys (Fig. 2). The turbines are horizontal wheels, and their vertical axes are geared by bevil wheels with the rope pulleys, by which motion is conveyed through cotton ropes to the two generating dynamos. The latter are six pole machines, each designed for an output of 330 amperes at 624 volts, and in regular work these machines are coupled parallel. The machines, and, in fact, the whole installation, with the exception of the hydraulic works, has been designed by Mr. Brown, to whom I am indebted for the particulars I now bring before you. The electrical part of the plant was made and

erected by the Oerlikon Engineering Works. The line consists of four cables (each having an area of $\cdot 437$ of a square inch), and is supported at four intermediate points, besides the supports at the terminuses. One of the intermediate supports is the old turbine house, which, in former times, was used in connection with the wire rope transmission; the others are towers of iron framework, 46 feet high, one of which is shown to a larger scale in Fig. 1. The span where the line crosses the river is 330 feet, and where it passes along the shore of the river the span is 430 feet.

You may imagine that the proper support

FIG. 2.



and insulation of cables of that size, and with so long a span, is a matter of considerable difficulty. The use of glass or earthenware insulators on a stalk, as employed for the support of telegraph lines and other light wires, is, of course, out of the question. We must have something very much more substantial, and this has been provided in the manner shown Fig. 5 (p. 715). Near the top of each post there are bolted to the iron framework four of the boxes shown on this diagram: one for each line of cables. The inner box serves as a kind of junction or connecting piece

between the cable ends, which are opened out as shown. Molten zinc is then run in, and surrounds every single wire, thus making a perfect electrical joint; whilst, at the same time, the strain is divided between all the wires in the most even way possible. The inner box is surrounded by an outer box, and the intervening space is cast out with sulphur, which is an excellent insulating material, and, applied in this way, of sufficient mechanical strength to resist the large forces involved in the supporting of these heavy cables.

In mountainous countries, where thunder-

storms are frequent and violent, the protection of lines from lightning strokes is a matter that must not be overlooked. The line I am describing is protected in a two-fold manner. In the first place, there is stretched over the four electric cables a steel wire rope, passing right over the supports, and in good electric connection with their iron framework, and therefore with earth. The object of this arrangement is to act as an ordinary lightning protector, on the supposition that a lightning flash will rather go to earth by way of the steel cable and one of the towers than run along the electric line. But lightning flashes are sometimes very erratic, as was shown experimentally in this very room, in the admirable "Mann Lectures" which Professor Lodge delivered before this Society in 1888. It is, therefore, also necessary to make provision for flashes which will, for some reason or other, stray away from the direct path provided for them; and this has been done in the Schaffhausen installation, by the employment of lightning arresters at both terminal stations. At each station there are four lightning arresters, one for each cable. They consist of a pair of toothed plates, of which, however, only one is fixed, the other being moveable. When a flash strikes one cable only, it goes to

earth by the corresponding plates, and no further damage is done. Should, however, both a positive and a negative cable be struck at the same time, then the arc set up between the plates by the passage of the lightning flash provides an easy path for the passage of the power current also; in other words, the generator will be short circuited. The object of making one of the plates moveable is to cut off the short circuit current before any harm is done to the machinery. The moveable plate of the lightning protector is connected to the core of a solenoid, through which the short circuited current must flow. Immediately this current is started, the core is sucked in, and the moveable plate falls away from the fixed plate, thus acting the part of an automatic switch.

Returning now to the Schaffhausen plant, the generating station contains two 300 horse-power dynamos, which are over-compounded, so as to produce a constant pressure of 600 volts at the motor station, the loss in the line being with full current 24 volts. These machines have series-wound drum armatures, running at 200 revolutions per minute. Their more important electrical data, as well as those referring to the motors, are given in the following Table:—

SCHAFFHAUSEN TRANSMISSION PLANT.

	Generators.	Twin Motor.	Small Motors.
Number of machines	2	1	2
Normal horse-power	300	380	60
Number of poles in magnet field	6	6	2
Revolutions per minute	300	300	350
Terminal voltage	624	600	600
Normal current amperes	330	500	81
Diameter of armature inches	47½	42½	23⅝
Length of armature core inches	20	20⅜	22½
Radial depth of armature core inches	8	7	4¼
Section of armature conductor square inches	103	1078	10287
Number of armature conductors	316	316	540
Number of commutator segments	153	153	90
Loss in armature resistance per cent.	1.46	1.52	2.7
Induction in armature C.G.S. measure	7,500	7,600	15,800
Shunt resistance ohms	140	143	295
Loss in shunt excitation per cent.	1.35	1.68	—
Main turns per magnet	6	4	—
Loss in main excitation per cent.	3	2	—
Type of armature	Drum.	Drum.	Cylinder,

FIG. 3.

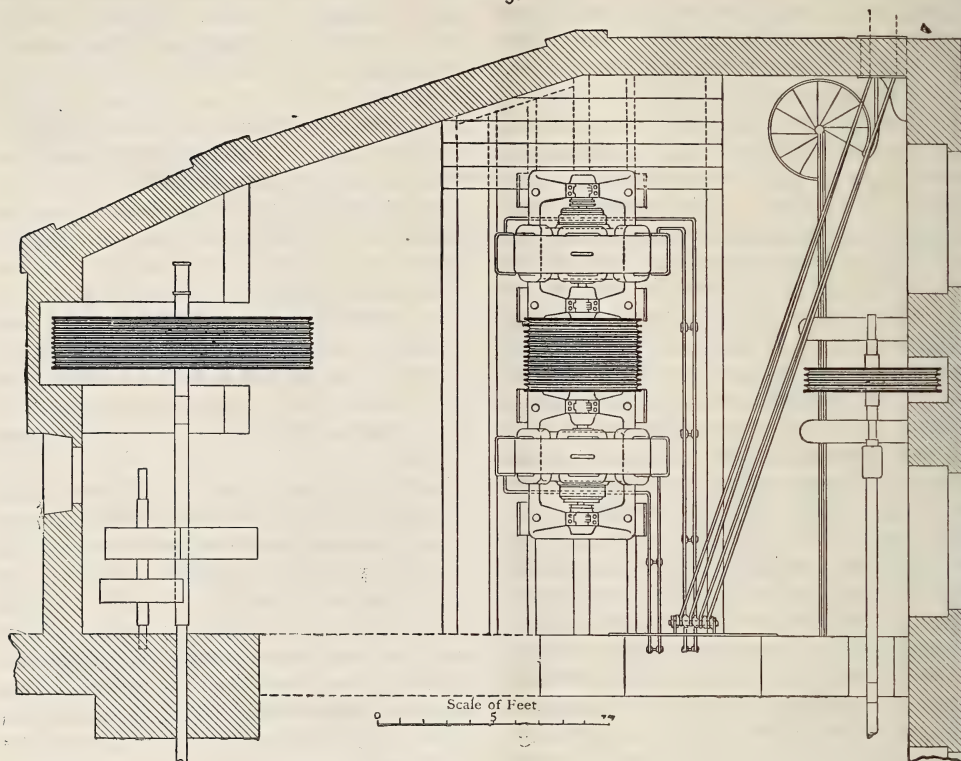
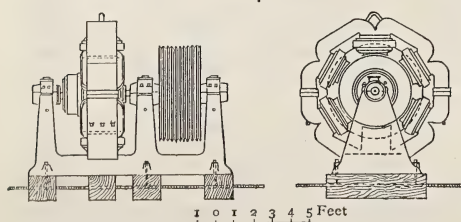


Fig. 4 shows a drawing of these generators. Fig. 3 is a drawing of the twin motor, which receives the bulk of the power at the spinning mills, whilst the remainder is taken up by a couple of two-pole motors, placed in other parts of the mills. These are not shown on the diagrams, as they are of the ordinary design, with which you are already familiar. The twin-motor is rated at 380, and each of

FIG. 4.

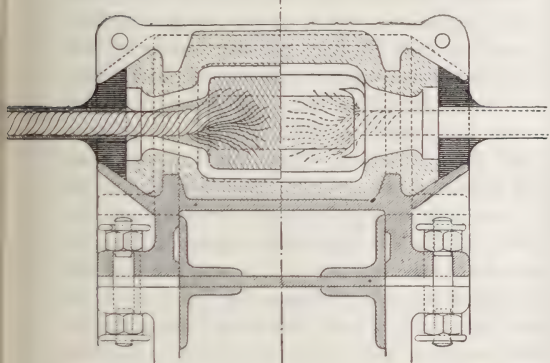


the single motors at 60 horse-power, making in all 500 nett brake horse-power delivered to the mill shafting. The coupling between the motors and the mill shafting is by cotton ropes, as shown in Fig. 3, the arrangement chosen having the advantage that very little side strain is thrown upon the motor bearings, owing to the ropes pulling opposite ways.

An interesting and novel feature of the plant is the arrangement adopted for starting gradually, and yet without the use of resistance. In my experiments last week I used current delivered at constant pressure; and, to start the motor gradually, and prevent sparking at the commutator, I was obliged to insert into the armature circuit a variable resistance, which was withdrawn after the motor had gathered enough speed to make this safe. There is no inconvenience in using such a resistance when we are dealing with small currents; but when it is a question of several hundred amperes, and the absorption of as many horse-power, the resistance becomes a very cumbersome and unwieldy appliance. To get over this difficulty, Mr. Brown has devised a very ingenious method of coupling between the line and machines, the essential features of which are shown in Fig. 6. As I have already mentioned, there are four main cables, two positive and two negative. Three of these cables contain no switches which need be used for starting, although of course they contain the switches and fuses which may be required for testing purposes and as safety devices, but these, not being

essential to the explanation of the starting arrangements, I have not shown in the diagram. Call the two outer cables positive, and the two inner cables negative. The positive cables are looped at both terminuses, and the inner cables are also looped in this way, but a switch is inserted in the right-hand cable at the motor station. Now imagine all the machines at rest, and this switch to be open. To start the plant, the turbine-driven generator, G_1 , is set in motion, and the speed run up till this machine excites itself by its own shunt. If you follow the connections you will find that the shunts of the other three machines will at the same time also become excited. The motors have now made their fields, and if we start the second generator, G_2 , slowly, a power current of gradually increasing strength will be sent through both motors, and the latter will gradually start. As they gather

FIG. 5.

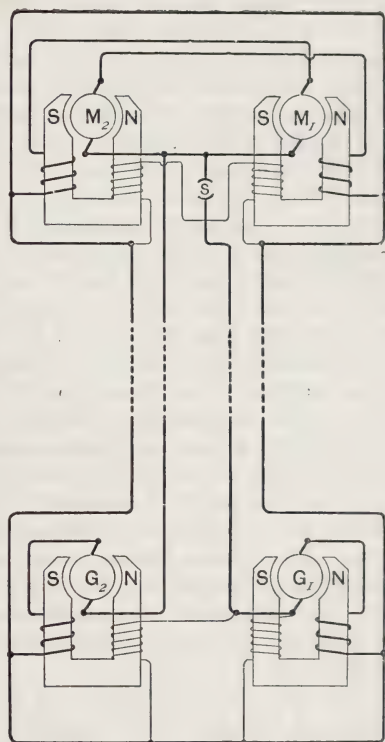


speed, their counter E.M.F., which is indicated by a voltmeter at the motor station, gradually rises; and if it has become equal to the E.M.F. indicated by a second voltmeter in connection with the current from the first generator, G_1 , the attendant closes the switch, and the operation of starting is completed. It should be noted that on closing this switch there is no sudden rush of current, since the pressure on both sides of the switch is approximately equal.

Originally the motors were intended to be pure shunt machines, but it was soon found that owing to the very small armature resistance and armature reaction, it was very difficult to get the load equally divided between them. Mr. Brown, to overcome this difficulty, hit upon the ingenious device of making the machines mutually control each other by putting on demagnetising main coils, and cross-

ing the connections between armatures and fields, so that the machine which might at any moment develop a tendency to take more than its fair share of current would have its field strengthened by the deficiency of current passing through its main turns to the other armature, and would thus immediately raise its counter E.M.F., and check the excess of current, whilst the other machine which was not taking enough current would have its field weakened, and would thus be forced to take more current. It is clear that by this cross-connection even a neglect on the part of the attendant to set the brushes properly cannot

FIG. 6.



materially influence the even division of current and load between the two machines. At the same time the demagnetising influence of the main coils has the same effect as if the armature reaction were increased, and insures thus constancy of speed, as I have shown you experimentally last week. In the diagram, Fig. 6, the machines are represented as if they had only two poles each. This I have done to make the diagram as simple as possible, and for the same reason I have shown the shunt and main coils on separate magnet limbs, but you will have no difficulty in trans-

lating in your own mind this principle of circuit connections to multipolar machines.

It may interest you to have a few details of a commercial nature regarding this transmission plant. The manufacturers have guaranteed a commercial efficiency at ordinary full load of 78 per cent., also that the machines must be capable of transmitting an excess of 20 per cent. over their normal power for one hour and a half without damage. The wear of one set of brushes to be not less than 2,000 hours, and the life of a commutator not less 20,000 hours. The variation of speed of the motors between running idle and under full load not to exceed 3 per cent. The total cost of the electrical part of the plant, including cable towers and erection, was £6,800, or £13 12s. per net horse-power delivered.

I have occupied some time in putting before you this transmission plant, because exact information about successful engineering work is of great value to practical men; and the Schaffhausen plant is certainly one of the best and most successful examples I could have chosen. The power transmitted is certainly large, according to our present ideas, but there is good reason to believe that—in point of magnitude, at any rate—this transmission will very soon be eclipsed by other work of this kind. There are projects afloat for utilising the power of the Rhine, near Bâle, to the tune of tens of thousands of horse-power, and at Niagara, as you all know, a total of 125,000 horse-power, or a little over 3½ per cent. of the total power of Niagara, is to be taken from the Falls and transmitted to various distances, the longest distance being some twenty miles. I am not in a position to give you details of any of the schemes which have been submitted to the Niagara Commission, since these are the property of the Cataract Company, but by the courtesy of several members of the Commission, notably Dr. Coleman Sellers, I am able to give you a general outline of the schemes. My object in applying to the Niagara Commission for information of this kind was to obtain some indication of the opinions which leading modern engineers entertain of electric power transmission, and to put the result of my inquiry before you. Lest the general condition of the Niagara scheme may not be quite familiar to all of you, I shall now throw upon the screen a picture of the Falls, and give you very briefly an outline of the objects for which the Cataract Company has been established.

Of the immense power represented by the

descent of the river from its upper to its lower level over the Falls (about 3½ million horse-power), there is utilised at present an aggregate of only about 5,000 horse-power in the mills you see on the left of the picture. The water is brought to these mills by a surface canal from the upper reaches of the river, and, after passing through turbines, is discharged into the open air about half-way between the level of the ground and the level of the river below the tail races, forming a number of miniature waterfalls. Only about half the available head is therefore utilised. If the system adopted hitherto could be followed in future, there would be little difficulty in establishing a station for the generation of any amount of power in this locality, but there is a strong tide of public opinion against the establishment of any more hydraulic works on the river bank, to say nothing of the difficulty of finding room for them and the open-air canal which would be required. The Cataract Company have therefore resolved to carry out their operations, to a great extent, underground; and at the present moment are driving a tunnel 30 feet high by 20 feet wide, and about 6,700 feet long, which is to serve as a tail race for the water coming away from their power-station. This tunnel is shown on the picture by two dotted lines, and its mouth is partly submerged under the level of the lower river. The total fall between the upper and lower river is 200 feet, and the net fall available for the turbines is 140 feet. The fact that the tail race is a tunnel, necessitates the turbines being placed at least 110 feet underground, since the suction tube of a turbine cannot be made longer than the column of water which can be balanced by atmospheric pressure, and this increases very materially the engineering difficulties of the work.

Last summer the Cataract Company invited a limited number of engineers to send in projects for the creation and transmission of power, and instituted a Commission, under the presidency of Sir William Thomson, to investigate and report on the projects. There were in all twenty competitors, but of these only fourteen complied with the programme drawn up by the Commission, and were therefore held to be qualified to have their projects examined. Of these fourteen, eight competitors sent in combined projects for the creation and transmission of power, four referred only to the creation, and two only to the transmission of the power. The point of interest to us

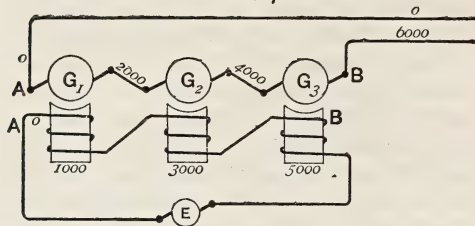
is what methods were suggested by the ten qualified competitors in transmission. The question is somewhat complicated by the fact that some competitors have suggested mixed systems of transmission, and that in classifying the schemes into electrical, pneumatic, and hydraulic, we must count some competitors twice over. On this basis I find that the following represents the transmission projects:—Electrical, 7; pneumatic, 6; hydraulic, 2. It is certainly remarkable that the balance in favour of electric transmission should be so small. And it is equally remarkable that there should have been as many as six competitors who either wholly or partly advocated pneumatic transmission. The experience of colliery managers goes to show that even over the comparatively short distances over which they use pneumatic transmission, the total efficiency lies generally between 20 and 30 per cent., and does certainly not exceed 40 per cent. We cannot suppose that engineers who have sent in pneumatic projects are ignorant of this fact, or at any rate we must suppose that the majority of them are quite aware that high efficiency cannot be expected from compressed air transmission. If, nevertheless, they have adopted compressed air in preference to electricity, it must be for one of two reasons. Either they have no confidence in the capabilities of electric transmission, or they consider the cost so high that the interest on the extra capital and the greater depreciation of the plant will more than counterbalance the advantage of high efficiency. It cannot be denied that in the present state of our knowledge of electric transmission, there is some ground for both these views. The Niagara problem is unique both in magnitude and distance, and I am bound to confess that we electrical engineers are at the present moment not quite prepared to face it. At the same time I must say that I feel convinced that in a few years from now there will be not one, but a dozen men ready to face this problem with a very good chance of successfully solving it. As a matter of fact, we are at present on the threshold of a new system of electric power transmission. The old system of using continuous currents and ordinary dynamos has been perfected to a point which leaves little to be desired, but it has its limits, and, unfortunately, the Niagara problem, or at least a part of it, is just a little beyond these limits. Hence we find that only about half of the competitors have had the courage to propose electric transmission. Of these, only two

suggested the use of alternating currents at voltages of 5,000 and 10,000 respectively; the others followed the old lines of continuous current transmission at voltages varying between 1,600 and 4,500 volts.

This brings me to the consideration of a subject which is of great importance not only in regard to the Niagara problem, but to long distance transmission generally, namely, the limits of distance up to which the usual system of transmission is practicable. If you will refer to the Table giving the cost of transmission plants, given in my last lecture (see *ante* p. 710), you will find that, for large powers at any rate, an increase of distance up to four or five miles does not make the cost prohibitive, and you will conclude from these figures that, within a five mile limit, the old system of electric transmission is certainly feasible. How much farther you might go is a matter for theoretical consideration; the Table does not help you much, as the only example of a very long distance transmission is one where the power is small, and is therefore, in a certain sense, misleading. I have given you a formula by which you can calculate the most economical voltage for any distance; and if you do this for many cases, taking, for instance, 500 horse-power as your unit of power, you will find that as the distance increases beyond about five miles, the economical voltage begins to grow beyond the limit which might be considered practicable for one machine. It is quite impossible to lay down hard and fast rules. Under certain conditions, especially if you have to transmit cheap water-power, you may possibly reach a distance of ten miles before getting to the limit of voltage; but whatever may be the special conditions of the problem, there is a limit of distance beyond which a single machine will not reach. "Very well, then," you might say, "if a single machine cannot be made to give the required pressure, let us put two or three machines in series." To correctly appreciate such a suggestion, let us first of all see what limits the voltage of a machine. Two things limit it; the commutator and the general insulation. Practical dynamo makers will tell you that in large machines they are quite prepared to put 1,000 volts on the usual Pacinotti commutator—if necessary, they will go to 2,000 volts, but with some misgiving; and if you ask them to make a machine for 3,000 volts, they will, as likely as not, refuse. I do not refer to the Thomson, Houston, or Brush machines, which have

special commutators, but to large machines giving an even current and a high efficiency, such as we require in the transmission of power. We may thus conclude that 2,000, or, at the outside, 3,000 volts, is the limit of voltage to be obtained from a single commutator. But the general insulation of the machine must also stand this pressure, and where, as in dynamos and motors, the insulation consists of cotton, paper, fibre, varnish, and like materials, which are subjected not only to electrical, but also to mechanical strains, 3,000 volts is quite high enough for safe working. The commutator difficulty can of course be got over by putting several machines in series and insulating their frames from earth. The difficulty of general insulation can, however, not be met so easily. This you will see by referring to Fig. 7, which

FIG. 7.



shows, diagrammatically, three 2,000 volt machines placed in series. Shunt excitation at the high pressure of 2,000 volts is, of course, out of the question; series excitation introduces complication and certain difficulties, especially at the motor station; and separate excitation, although simple and easily worked, has the disadvantage of throwing great electrical strains upon the insulation between the exciting coils and the frames of the machines. Imagine, for instance, that there is a weak place at A, between the exciting coil and the frame of the first machine, then the strain between the exciting coil and the frame of the third machine at B will be about 6,000 volts, even if all the machines are perfectly insulated from earth. With series self-exciting machines, the strain would of course be limited to 2,000 volts, but there still remains the difficulty that all the armatures would have to be mechanically connected by insulated couplings, and there would also be great danger in touching even the iron frame of any machine. You see the use of several machines in series is not such an easy matter as it may look at the first glance, and this method has, as far as I know, only been adopted in cases where the total voltage was under 2,000.

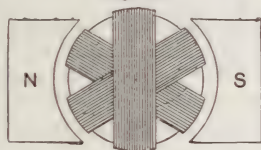
The net result of our investigation may be stated by saying that the electric transmission of power by continuous currents is economical and safe up to distances for which the most economical voltage does not exceed 2,000, or, at the outside, 3,000 volts, but that beyond these distances some other system must be applied. That this other system must also be electrical is evident, for we know perfectly well that distances beyond the reach of our present electric transmission systems are hopelessly beyond the reach of lines of shafting, flying ropes, air, or water. Now what is this new electrical system which shall enable us to carry power over ten or twenty, or perhaps a hundred miles?

In attempting to answer this question I must perforce leave the safe ground of solid facts and engineering practice, and enter into the domain of speculation. Yet speculation based upon experimental results which in themselves are as reliable as were those experimental results which have led to the practical development of electric-power transmission as we know it now.

The starting point in the theory which I have now to bring before you is the well known disc of Arago. If a copper disc be rapidly revolved under a compass needle, the latter is also set into rotation. I am able to show you this experiment, by the kindness of the Science and Art Department, who have lent me the apparatus you see before you. Between the copper disc and the compass needle is placed a sheet of glass so as to prevent air currents from affecting the needle. If I set the disc in motion you see that the magnet very soon follows. To make the motion of the latter better visible, coloured pieces of paper are attached to the poles. Now the fact that the magnet revolves is evidently due to there acting upon it some mechanical force. The explanation is perfectly simple. The disc, in passing under the poles of the magnet, becomes the seat of a very complex system of electromotive forces, which produce an equally complex system of currents. Some of these currents cross the path of the lines of force emanating from the magnet, and thus mechanical forces are set up between the disc and the magnet, causing the latter to rotate. It is as though there existed between the disc and the magnet a kind of electromagnetic friction by which the magnet is dragged after the disc. Since all motion is relative, it is perfectly clear that we might regard the magnet as revolving, and then the disc will be

dragged after it. With the apparatus before you this experiment would not succeed, since the magnet is small and the disc is heavy; but if we were to employ a very strong magnet, and revolve it rapidly enough, there would be no difficulty in setting the disc in rotation, and even obtaining power from it. I have said a moment ago that the system of currents set up in the disc is very complex, and you will easily see that only those currents which are more or less radial, and of these only their radial components, are instrumental in exerting mechanical force, whilst all the other currents represent simply so much waste power. To make an efficient machine we must, therefore, not employ a continuous disc, but a system of conductors, so arranged as to force the currents to flow as much as possible in a radial sense, and only in those places which are immediately under the influence of the magnetic field. Or, better still, we may abandon the disc shape of conductors altogether, and substitute an armature with a laminated iron core of the drum type, seen end on in Fig. 8, and use, instead of a straight

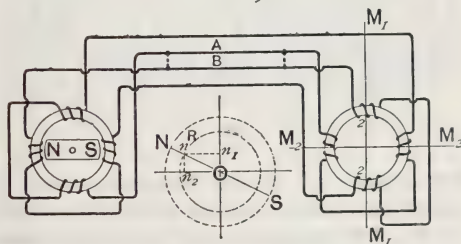
FIG. 8.



magnet, a horse-shoe magnet, so shaped as to bring its poles, N S, to opposite sides of the drum, and wind the latter with a number of coils closed in themselves. If we now revolve the magnet, strong currents will be generated in each coil successively, and a very strong torque will be exerted on the armature. The torque will, in fact, be comparable to that required to revolve an ordinary continuous current drum armature in a strong field, if we short circuit the brushes. Here, you see, we have, by applying a few very obvious improvements to the Arago disc, at once obtained a machine of very considerable power. Imagine both the magnet and the armature mounted on independent spindles (not shown in the diagram, but passing both at right angles through the centre of the figure), then it is perfectly clear that power given to the magnet spindle is transmitted, by electro-magnetic induction, to the armature; and a large portion of it may, therefore, be obtained again from the armature spindle. Here we have, certainly, transmission of power, but not of the kind we

require, since the distance of transmission is nothing. Now, what we want to do is to so alter our machine so as to separate the two parts. We want the magnet in one place and the armature in another place, miles away. If, in this case, we succeed in transmitting rotation from the magnet to the armature, then we shall have solved the problem. This problem has been solved by an Italian electrician, Professor Gallileo Ferraris, of Turin, who, early in 1888, communicated to the Turin Academy the results of his investigation on rotating magnetic fields produced by alternating currents. To clearly see the bearing which Ferraris' investigation has on our problem, let us inquire what it is we want at the motor station. We want there an armature, as shown in Fig. 8, and a magnetic field, the lines of which shall pass through the armature, and shall revolve round its centre. Whether the field is due to a real magnet, or is produced by any other means, is immaterial; and it is the merit of Ferraris to have shown us how to produce such a revolving field without the use of a real magnet, but simply by the use of two distinct alternating currents passing through fixed coils.

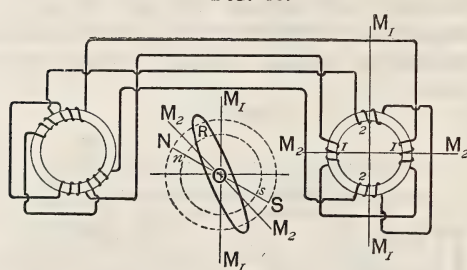
FIG. 9.



As the subject is new, and will not be found in any of the numerous text-books dealing with electrical engineering, you will perhaps not think it out of place if I put it before you in rather an elementary manner, beginning with the simplest possible case, and passing gradually to the more complicated cases. Assume, then, a combination of apparatus, as shown in Fig. 9. Here you have, on the left, an annular iron core wound with two coils, which are connected in series, and to a pair of line wires going to a similar coil on the right, which may be at any distance. Into the circular space enclosed by the first coil we put a straight bar magnet, N S, which can revolve round the centre. As the poles sweep past the wire turns, an E.M.F. is induced, and a current is caused to flow, the direction of which changes twice in every revolution. We

have here, in fact, an ordinary alternate current generator with stationary armature, and revolving field magnet. By suitably proportioning and placing the various parts of the apparatus, we can make the E.M.F. and the current curve of a true sine character; and, in order to simplify the treatment, I shall assume that in this, and in the cases which follow, the design is such that all the E.M.F. and current waves follow the sine law. The alternating current, in passing through the coils on the right, magnetise the iron core, so as to develop north and south polarity in the line $M_1 M_1$. The effect is the same as if we placed into the ring a vertical magnet which is collapsible, the two poles shrinking into a point at the moment that the current strength is zero, and coming apart vertically as the current increases. We must imagine this magnet alternately shrinking into nothing and growing larger and stronger; also reversing its polarity each time that it passes through its

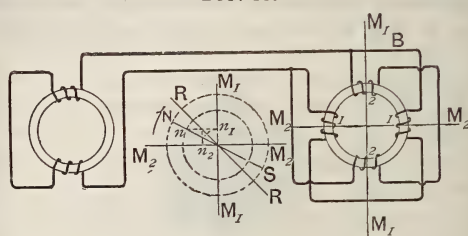
FIG. 10.



zero condition. In the apparatus shown by Fig. 9, therefore, rotation of a real magnet on the left produces merely an oscillating magnetic field on the right. As you know, a magnetic field may be represented graphically, in direction and magnitude, by a straight line; and, in this particular case, the line so representing the oscillating field is the projection of the radius, On , on the vertical $M_1 M_1$, if the length of the radius, On , represents the strength of the field at maximum current. At the moment to which the diagram refers, our collapsible magnet will, therefore, have grown to the strength represented by the length, $s_1 n_1$; and, if there were no lag, the real revolving magnet would, at that moment, occupy the position, SN . As there must be some loss in the transmission, I have shown N at a larger radius than n . If there is lag, then n and N will not lie on the same radius, but n will occupy, say, the position n' , and the strength of the oscillating field will be n'_1, s'_1 . The practical effect of lag is this, that the re-

volving magnet will have passed the vertical position shown in the diagram by the time the current has reached its maximum; and I can, therefore, eliminate the lag from the graphic diagram, by assuming that the revolving magnet has been shifted back through an angle equal to the angle of lag in this diagram, but left in its true position in the diagram representing the apparatus itself. In Fig. 9, the coils on the ring on the right hand are placed on the horizontal diameter. If, as in Fig. 10, I place them on the vertical diameter, the resulting oscillating field will be horizontal, namely, on the line, $M_2 M_2$; and the projection of n on the vertical must be taken over to the horizontal, as shown by the dotted quarter circle. Let us now suppose that we have both horizontal and vertical coils on the ring, as shown in this figure, then the combined effect of these coils will be to produce an oscillating field on the line, RR , the strength of the field being, as you will easily

FIG. 11.



understand, about 40 per cent. greater than in either of the former cases; but still the field is not a revolving one. I can show you the production of an oscillating field, as here explained, by means of a mechanical model.

Up to the present, then, we have not advanced in the solution of our problem. We have produced at the distant point an oscillating field; but what we want there is a revolving field; and to get this we must duplicate the apparatus shown in Fig. 9, by putting horizontal coils on the generator and vertical coils on the motor ring, in addition to the coils already there. This arrangement is shown in Fig. 11. Now, the field produced by the coils, 11 , is given by the projection of On on the vertical; and that produced by the coils 22 is given by the projection of On on the horizontal. The resultant of these two fields is therefore On , the point n revolving round O as a centre on the circle R . The effect of revolving a real magnet within the generator ring is, then, to produce a revolving magnetic field of the strength On

within the motor ring, a kind of revolving phantom magnet which, for our purpose, is quite as suitable as a real magnet. I can also show you this effect by means of the mechanical model.

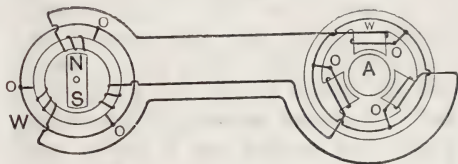
You observe that in Diagram 11 four wires are shown, connecting the generating and receiving machines. Now as the absolute potential of any of these wires may be chosen arbitrarily, there is obviously nothing against choosing it at such a value as will make it coincide with the absolute potential of another wire not belonging to the same circuit. We might thus, for instance, equalise the potential between the wires A and B by connecting them at either terminus, as shown by dotted lines, and not disturb in any way the satisfactory working of the machines. Or, better still, we may omit one of the wires altogether, and use the other as a common wire for both circuits, and thus reduce the total number of wires to three. The common wire must, however, have about 40 per cent. more carrying capacity, since the algebraical sum of the two currents is 1.4 times the strength of each current taken singly. Here you have, then, the theoretical solution of the problem of how to transmit power by alternating currents as indicated by Ferraris, but the first to attack this problem practically was Mr. Tesla, an American electrician, and such motors are therefore also known under the name of Tesla motors, though the name "Ferraris motors" seems to me to be more appropriate, as distinguishing this motor from the two wire Tesla motors, about which I shall say something presently. To carry out a power transmission by means of such a system, we must have at the generating station an alternator, the armature of which is wound with two circuits giving currents with a quarter period phase difference, three line wires, and a motor having a laminated field magnet, which is excited by coils placed alternately in the two circuits so as to produce a revolving field. The armature of this motor must have an iron core, surrounded with coils closed in themselves.

The necessity of using three line wires is, to a certain extent, a disadvantage of this system, and several engineers, Mr. Tesla foremost amongst them, have tried to improve the system in such way that two line wires only should suffice. The methods suggested have this in common, that all aim at producing a difference in phase between the currents passing through the motor, without the use of a second set of coils on the generator. If we

insert, for instance, a large inductionless resistance into the branch B in Fig. 10, and a coil having very little resistance, but great self-induction, into the branch A, the current in the coils 1 1 will lag by a small amount behind the E.M.F. impulses of the generator, whilst the current in the coils 2 2 will lag behind these impulses by a larger amount. The phase difference between the two currents can, of course, not amount to 90° , which angle is required for producing the best effect, but some difference of phase can certainly be produced in this way. The arrangement will, in fact, be equivalent to that shown in Fig 12, where the distance between the two sets of coils on the generator is less than 90° .

An easy geometrical construction, which I need not explain at length, shows that in this case the path of either pole of what I have before called the revolving phantom magnet is an ellipse, but that it can be made to be circular by a dis-symmetrical arrangement of the coils on the motor, though in this case the diameter of the circle is much reduced. In either case the value of the machine as a power-producing appliance is also much re-

FIG. 12.



duced, whilst at the same time the efficiency must be low, owing to the waste of power in the resistance coil. I can also show you the action of this two-wire motor by means of the mechanical model.

Owing to the low efficiency and small power of the two-wire revolving field motor, its employment is necessarily restricted to cases where these defects are of little consequence, but for the transmission of large powers over long distances it is not suitable. For such a purpose we must have three wires, but this is not a great drawback since the cost of the line is but little increased by the necessity of splitting up the total weight of copper into three instead of into two wires. The revolving field motor has, however, the defect that it is not self-regulating. Its speed may be anything between zero and that speed which will give synchronism between the two machines accordingly as the mechanical load varies from a maximum to nothing. This defect can be overcome by combining with the armature in

the motor a real magnet which will force the armature to keep step with the current, and thus insure a constant speed at varying loads. The motor will thus start with great power by virtue of the currents induced in the armature-winding by the revolving field, and having reached the synchronising speed it will keep there by virtue of the interaction between the revolving field and the revolving magnet; it will, in fact, behave just like an ordinary alternator run as a motor, with this difference, however, that the ordinary alternator, if overloaded by 50 or 100 per cent., will be thrown out of step and come to rest, whereas the combined Ferraris and synchronising motor will always be ready to recover itself after the overload has been removed.

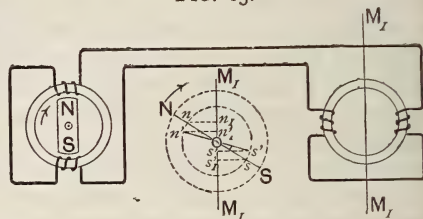
Since the discovery of Ferraris has been made public many engineers have turned their attention to revolving field motors, and especially to a modification of this principle, according to which three sets of coils are employed instead of two sets only. As far as I have been able to trace the history of this invention, the first to suggest the use of three coils were M. Tesla and Charles Bradley. The latter applied in the United States for a patent in 1888, which bears the number 409,450, and was granted on the 20th August, 1889. Next comes Wenstrom with his British patent, No. 5,423, of 1890, and at about the same time Dobrovolsky, in Berlin, had worked out a similar system. About a year ago, when I visited him at the works of the Berlin Electrical Company, he showed me such a three-wire motor in action, whilst shortly afterwards Charles Brown, of Oerlikon, took the matter up, and it may interest you to learn that he is at the present moment putting up a 500 horse-power transmission plant on this system between Bülach and Oerlikon, a distance of 15 miles. This transmission is intended to supply all the power required in the Oerlikon Works. The general principle forming the basis of the work done by these various inventors is illustrated in Fig. 13. The generator contains a revolving field-magnet, and an armature wound with three distinct coils. The end, O, of each coil is joined to a wire, W, common to all, and the three free ends are joined with the three-line wires. At the receiving station there is a three-legged magnet, the coils on the legs being in connection with the line wires on the one side, and joined by a common wire, W, on the other side. It is easy to see that the rotation of the field

magnet in the generator will produce successive polarities in the legs of the receiving magnet, and that the general effect will be that of a revolving field. The armature, A, will, therefore, be set in rotation in the same way as is the case in the original Ferraris motor. This kind of transmission is known in Germany under the name of transmission by the "three-phase current," and it is likely that it will, ere long, become a strong rival to the ordinary alternating current.

The diagrams I have brought before you were all drawn for two-pole machines, as this was the simplest way of making the principles clear; but I need hardly say that, in practice, the machines are made of the multipolar type, in order to bring the speeds down to any desired value.

You will, perhaps, ask why we should go to the complication of three-line wires and a totally new type of motor, seeing that, with the ordinary dynamos and motors, such excellent results have been obtained, and that with only two-line wires. My answer is that,

FIG. 13.



with this new system, we can greatly extend the distance of transmission. I have spoken, a short time ago, of the difficulties which the high voltage required in long-distance transmission, raised in connection with the commutators and general insulation of machines. Now, in the three-wire system of transmission, by alternating currents, we have no commutators, and, in fact, not even rubbing currents. One of our difficulties has, therefore, already vanished. As to the other, which has reference to the general insulation of the machines, it is easy to see how this may be overcome. We need only, instead of working direct, work through transformers. The insulation of transformers offers no difficulty whatever. I have here on the table a transformer of the type made by Messrs. Johnson and Philipps, which has been designed specially for high-pressure currents, and is provided with oil insulation. I have recently used two of these transformers for testing a Brook's line. In one transformer the pressure was raised from

2,400 to 17,000 volts, the high-pressure current was sent through the line, and, at the other end, it was again transformed down to 2,400 volts, and, finally, to 100 volts, for lighting glow-lamps. The apparatus was kept running for several days without any difficulty. Mr. Brown informs me that he has with oil insulated transformers, and even gone up to 36,000 volts, without breaking down the insulation, and the Bülach-Oerlikon transmission will be made at 25,000 volts, whereas the machine will work only at a few hundred volts. There is thus no difficulty in adopting whatever voltage is most economical in each case, and yet avoiding all danger, either to the attendant or to the machines themselves, at the generating and motor station.

I feel that I owe an apology for having occupied so much of your time with discussing a branch of power transmission which, to many of you, must seem to be purely theoretical, and hardly ripe for discussion. My excuse must be that I am very strongly convinced that some form of alternate current working will be the ultimate solution of the problem how to transmit power—possibly over all distances, but certainly over very long distances—and that I was desirous of directing the attention of electrical engineers to a subject in which much work may still be done.

ELECTRIC MACHINE TOOLS.

In concluding my lectures, I wish to bring before you a few examples of short distance transmission as applied to electric machine tools. This branch of our subject has of late years received considerable development at the hands of various English firms, and, thanks to their enterprise and perseverance, is now a well-established method in several engineering works.

As an example, I may mention the Leven Shipyard of Messrs. Denny Brothers, at Dumbarton, and Mr. Archibald Denny has been good enough to give me some particulars of the work carried on by his firm in this direction. I cannot do better than quote his words:—"In our yard and engine works we have numerous instances of electric transmission of power. In our experimental tank we drive our model cutting machine and small lathes by means of a 3 horse-power Immisch motor. In our upholstery department we drive six sewing machines with a 2 horse-power Immisch motor; of course in this case there is a large margin of power. In our experimental tank we have also used small motors

for driving small model paddle wheels in our experimental models, and have obtained in this way most valuable data, which we could not have got by any other means. The power for all this work is obtained from a dynamo driven by an ordinary line of shafting in our joiner's shop. We also use a 3 horse-power motor in the yard for boring the stern tubes in place; before this we used a portable engine, which necessitated an attendant to fire the boiler and carry water to it."

"During the holidays, when all the boilers are off except one, we occasionally put down a motor for driving some lathes to do repair work, and this saves an attendant at more than one boiler. In our engine works the pattern shop is driven by a 15 horse-power Manchester motor, the dynamo being driven off the line of shafting in the fitting shop."

You see, Messrs. Denny Brothers find electric power transmission so handy, economical, and convenient, that they make extensive use of it. They employ a special tool for drilling the sole plates of engines, which I now show on the screen. The weight of the machine is sufficient for the pressure required on the drill, and the whole apparatus being mounted on wheels, it can be rapidly shifted. The machine will drill $1\frac{1}{4}$ inch holes through two thicknesses of inch plate in three minutes.

Another machine used at Leven Shipyard is a special drill for butt straps. The motor and gear are mounted on a stout vertical column with horizontal arm, so as to give adjustment in both directions, the column being bolted to the strap, as shown. The machine will take in straps 50 inches deep by 23 inches between outer rows of holes, and is chiefly used for drilling sheer strake double butt straps. The outside strap is first punched and counter-sunk, and the machine drills through the plate and inside strap. The machine is worked by two men—one hole-borer and one labourer—and will do three straps, or about 180 holes per day.

The rivet holes in boiler furnaces are also drilled by an electric tool, which I illustrate on the screen. The machine has a tripod stand arranged to go inside the furnace, but it has also holding-on magnets for outside work. One man with this machine does the work which formerly required three to four men.

No account of electric machine tools would be complete if it did not include the work done by Mr. Rowan, who has been very successful in developing this branch of power transmission. Amongst the improvements Mr. Rowan

introduced is that of holding-on magnets, whereby the tools are firmly held in place while at work, and yet by the mere turning of a switch become liberated and can be shifted to a new position with the greatest ease. You see on the screen some of Mr. Rowland's drillers as applied to ship work. The apparatus is suspended on a chain over the ship's side and supplied with current by means of two flexible wires. I need not detain you with a description of the picture on the screen because I can show you the actual machine at work, thanks to the kindness of Messrs. M'Whirter, Fergusson and Co., the makers, who have sent me one of their latest machines for this lecture.

I am also indebted to Mr. Webb, the Locomotive Superintendent of the London and North-Western Railway, for the loan of one of his electric tube cutters which you see before you, and which I shall now work. A diagram of this machine to an enlarged scale is on the wall.

These few examples of what are properly called electric machine tools must suffice for this lecture, but there is another class of apparatus, namely, electric mining machines, which ought to be included in our subject. Several firms, both here and abroad, have of late years devoted considerable attention to the application of electric power to mining operations, such as pumping, hauling, coal-cutting, and drilling. Messrs. Goolden and Co., for instance, have during the last four years steadily and perseveringly worked out many of the difficult problems in connection with this subject, and I am indebted to this firm for the loan of the apparatus you see here, and also to Mr. Atkinson for assisting me in setting the machines up. After the excellent paper which Mr. Atkinson read at the Institution of Civil Engineers, only a few weeks ago, it would be occupying your time uselessly if I were to give any lengthy description of these machines. I shall, therefore, merely show two types of mining motor on the screen and show you a drill at work.

I have in these lectures not attempted to treat exhaustively any one branch of the subject, but have rather endeavoured to pass the various branches in rapid review, so that you may know what electric transmission of power can do and what it cannot do. We hear nowadays very frequently the assertion that electricity is but in its infancy and will ere long be the sole motive power, driving our main-line trains, speeding our vessels across the ocean,

and running our factories. These are idle dreams, ideas put forward by persons who have forgotten or have never learned the fundamental laws of nature. Do not waste time over such ideas, for there are other more hopeful problems, such as the utilisation of water power generally, of waste coal at the pit's mouth, the working of railways in mountainous districts, where water power is abundant all along the line, the working of tramways, underground town railways, the application of electric power to such purposes for which now small auxiliary steam engines are employed, and last, but not least, its application to machine tools and other special machinery, of which I have given you examples to-night.

Miscellaneous.

PATENT'-OFFICE.

The Report of the Comptroller-General of Patents for the year 1890 has just been issued. It shows the usual growth in the number of applications for patents, which has now reached the very high figure of 21,307. In the first year since the last change in the law—1884—the number sprang up from 5,993 to 17,110, the highest figure, 6,241, having been reached in 1882. In the following year the numbers fell a little, to 16,101; but in 1886 they increased again, and the increase has been steady down to the last year for which we have a record. The revenue of the office is very large, £192,606. Of this, £83,240 was expended, leaving a surplus for the year of £109,366. This surplus is not equal to that annually earned under the older system, the surplus income for the year 1883 amounting to £172,527, the total revenue for that year being £224,956. The diminished income is of course due to the lowered scale of fees.

The largest increase in expenditure is in the item of salaries, which has grown from £30,811 to £52,527. Although the number of applications printed is so very much larger, the printer's bill shows but a small increase, being £17,000 against just £15,000. It should also be noted that the fees from trade marks for the past year are very much greater than they were in 1883, being £16,427, as compared with £5,060.

The report also gives information as to the other departments of work of the Patent-office, lists of the places to which grants of the specifications are made, and a copy of the "Patents, Trade Marks, and Designs Rules," now in force, together with the forms employed under them,

DEVELOPMENT OF SPANISH-AMERICAN TRADE.

It is stated in a report recently issued by the United States Government, on the subject of trade and transportation between that country and Spanish America, that people who have not studied the question have very little conception of the magnitude and value of the foreign commerce of Central and South America. The 50 millions of people south of the Rio Grande and the Gulf of Mexico are engaged in a trade which amounts to 1,000 millions of dollars annually, nearly equally divided between exports and imports; and in the countries south of the Tropic of Capricorn, those of the temperate zone of South America, the foreign trade is increasing with amazing rapidity. The total value of the foreign commerce of these countries increased from 709 million dollars in 1870 to 1,014 millions in 1884, a gain of 305 millions, or 43 per cent. This increase of commerce during the period indicated, compares favourably with the increase in the trade in merchandise of the principal commercial nations of the globe, being, for example, greater than that of Great Britain, which increased 27·2 per cent. The trade in merchandise of the United States increased from 829 million dollars in 1870 to 1,547 millions in 1884, showing an increase of 86·7 per cent. The imports of Latin America during the same period increased from 337 million dollars to 460 millions, a gain of 123 million dollars, or 36·6 per cent.; and the exports from 372 millions to 550 millions, a gain of 178 million dollars, or 48 per cent. In 1886, the latest year for which the complete statistics are available, the foreign trade of Latin America reached a total of 973 million dollars, of which 474 million dollars were imports, and 499 millions were exports. Of this trade Brazil had the greater share, her imports amounting to 108 million dollars, her exports to 105 millions, and the total foreign trade to 213 millions. The Argentine Republic came next in the order of importance, with 98 million dollars for the imports, and 70 millions for exports, making a total of 168 million dollars. Cuba came third with a total trade amounting to 125 million dollars, divided as follows—imports 58 millions, and exports 67 millions. Chili is next on the list with 40 million dollars imports, 51 millions exports, making a total of 91 millions. During the period between 1870 and 1886 the total gain was 264 million dollars. The greatest increase was seen in the Argentine Republic (99 million dollars), the next Cuba (36 millions), then came Chili (24 millions), and Brazil (21 millions). The increase in Uruguay was 16 millions, in Venezuela 15 millions, and in Colombia 10 millions, while all the other nations shared in lesser proportion. If, says the report quoted above, a comparison could be made with the year 1888, a still greater increase would be shown, for there is no doubt that during that year the commerce of Latin America surpassed even that of the year 1884, and exceeded 1,000 million of dollars,

SPIDERS AND ENGINEERS.

Ever since the story of Robert Bruce and the spider, that insect has been proverbially held up to view as an example of pertinacious skill. An attempt to establish instinct as a guide to reason is, however, a fallacy. The setting hen is an example of instinct, not maternal constancy. This perseverance of spiders may have been an encouragement to Robert Bruce, but it is often a discouragement in engineering work. In sinking plumb lines down shafts for middle headings in tunnelling, in order to obtain an alignment for the tunnel, the accuracy of the work is often seriously impaired by spiders attaching their webs to the lines and drawing them towards the walls with sufficient tension to introduce material errors in the position of the plumb bobs. In fixing the alignment of Hoosac Tunnel, Massachusetts, U.S., at the bottom of a shaft 1,028 feet deep, the spiders prevented accurate work with plumb lines, until two cases were made inclosing the whole length of these lines. For shallow pits the spiders' webs can be broken by raising the lines and then lowering them to position shortly before fixing upon points; but in this instance the distance was so great as to require several hours before the vibration of the lines would cease even with the bobs in vessels of mercury. The suggestion is made that the lines might be freed from similar interferences by insulating the suspended apparatus and the bob from the earth and attaching a grounded electric light circuit to the wire, relying upon the dampness in the pit to give sufficient conductivity to the cobwebs to cause them to be seared by the escape when any cobweb connected the earth to the plumb-wire. Many years ago when the writer used the level in an engineering party there were frequent difficulties with the instrument. Curved lines like arcs of circles would appear in rapid sequence across the field of vision, which would be nearly eclipsed at times. These difficulties would arise at irregular and generally inconvenient intervals. The instrument was carefully examined without revealing any cause. The writer, distrustful of his own eyesight, visited an eminent oculist, receiving some vague advice and paying a realistic fee. It was afterwards discovered that a minute spider had ensconced himself in the cover of the eyeglass of the telescope of the level. Recently it was found that the meter in the store of a patron of an electric lighting station in America was recording what was a small fraction of the electricity known to be used. The meter was of the revolving fan type, and it was found that a spider had entered the case through a screw hole and spun a web in such a manner as to prevent the free revolution of the fans. If gas meters were susceptible to similar treatment it is feared there might be a tendency to perforate the cases and imprison spiders therein,—*Engineering*.

Notes on Books.

FAMILIAR OBJECTS OF EVERYDAY LIFE: a Handbook of Lessons in Elementary Science. By Joseph Hassell. London: Blackie and Son. 1891.

The purpose of this book is to assist teachers in the teaching of science in elementary schools, and the chapters are for the most part enlargements of notes of lessons given by the author to classes of young children. The general course commences with a description of the various objects necessary for the production of a letter, of postage, and of money; food substances, natural phenomena of common English small birds, parts of a plant and substances used in the arts and manufactures are then described. Courses in mechanics, natural history, botany, agriculture, chemistry, sound, light and heat, magnetism, and electricity follow, and the work is concluded with courses in domestic economy, common animals and plants, and lessons on inorganic substances.

AN ELEMENTARY TEXT-BOOK OF PHYSIOLOGY.

By Vincent T. Murché. London: Blackie and Son. ELEMENTARY BOTANY. By Joseph W. Oliver. London: Blackie and Son. ELEMENTARY CHEMISTRY. By W. Jerome Harrison. London: Blackie and Son.

Of these educational text-books, that on physiology was originally designed for elementary schools, but it has been adapted for use by classes studying the first stage of the Science and Art course. The botany is intended for the use of students in the classes under the Science and Art Department, and the chemistry for the public elementary schools, that being one of the specific subjects in the Elementary Code. All these text-books are fully illustrated.

VENTILATION: a Text-book to the Practice of the Art of Ventilating Buildings, with a supplementary chapter upon Air-testing. By William Paton Buchan. London: Crosby, Lockwood and Sons. 1891.

The author discusses the questions which arise in respect to the application of the principles of ventilation to the preservation of a pure air in schools, churches, halls, houses, and other enclosures where human beings live, meet, or work. A special chapter is devoted to railway carriage ventilation, and the author points out that while in many schools the cubic space allotted to each pupil is 140 cubic feet, in a railway carriage seated for ten persons there is usually only about 26 cubic feet for each person, or only about 200 feet for the whole ten. To obviate this evil it is necessary to open the windows and obtain a thorough draught. The evil is much aggravated in the case of smoking compartments, and the author shows the need of a provision for carrying off the vitiated air at the roof.

MOFFATT'S NEW GEOGRAPHY, written for the present time, being a Manual of Geography, Astronomical, Physical, Commercial, and Political. Edited by Thomas Page, and revised by Rev. E. Hammonds. London: Moffatt and Paige.

As the title indicates, this work deals with mathematical or astronomical geography, physical, political, and commercial geography, as well as the ordinary descriptions of the divisions of the globe. Under the heading of commercial geography, an account is given of aids to trade and commerce, and notices of the principal productions forming articles of export and import. In the portion of the work devoted to the division of the globe, the whole of the British empire is given continuously.

General Notes.

TUSSUR SILK.—Mr. M. M. Bhownaggee, C.I.E., in a speech at the annual dinner of the Silk Association of Great Britain, referred to Mr. Wardle's paper on "Tussur Silk," read before the Society of Arts on May 14th last (see *ante* p. 607), and in answer to Sir George Birdwood's question in the discussion, why India had failed to profit by Mr. Wardle's teaching, he said, "I can explain the reason. While you gentlemen are engaged in developing such industries as constitute the wealth of your nation, we, in India, are only industrious in manufacturing Bachelors and Masters of Arts. The mad race after so-called academic education on which people in India are started, accounts for a good deal of their sad neglect of solid industrial pursuits. They have been gradually losing most of their handicraft which once made them famous. When Lord Reay attempted to direct some of the educational aspirations of my countrymen into technical and industrial channels, popular as he was, the so-called advanced educationists in India cried out against him." Mr. Bhownaggee further regretted "that any bale of raw produce from India should ever come to this country," and added, "I am grieved to think that India should be so utterly incapable of manufacturing its own raw produce as to let it all go out of the country."

INDIAN COAL PRODUCTION.—From a statement of the production of coal in British India in 1889-90, received by the Board of Trade from the India-office, it appears that the production in Bengal, in 1889, was 1,541,356 tons, and in 1890, 1,626,245 tons; Punjab, 22,835 tons and 40,677 tons; Central Provinces, 144,465 tons and 137,022 tons; Assam, 116,676 tons and 145,708 tons; Central India, 52,956 tons and 77,842 tons; Nizam's Territory, 59,646 tons and 125,486 tons; Beluchistan, 7,420 tons and 15,541 tons; total production in 1889, 1,945,354 tons, against 2,168,521 tons in 1890.

Journal of the Society of Arts.

No. 2,018. VOL. XXXIX.

FRIDAY, JULY 24, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

COUNCIL MEETING.

A special meeting of the Council was held on Monday last, the 20th inst., to receive the members of the United States Commission, now visiting Europe in connection with the World's Columbian Exposition, to be held at Chicago in 1893.

The members of the Commission present were:—The Hon. Benjamin Butterworth, the Hon. A. G. Bullock, and Major Handy, with Mr. R. S. McCormick, Secretary in the United States Legation.

The members of Council present were:—The Attorney-General, M.P., Chairman; Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Deputy - Chairman; Sir Frederick Abel, K.C.B., D.C.L., D.Sc.; William Anderson, M.Inst.C.E., F.R.S.; Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.; Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Michael Carteighe; R. Brudenell Carter, F.R.C.S.; Sir George Chubb; Lord Alfred Churchill; B. Francis Cobb; Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E.; Prof. James Dewar, M.A., F.R.S.; Major-General J. F. D. Donnelly, C.B.; Sir Henry Doulton; James Dredge; Sir Douglas Galton, K.C.B., D.C.L., F.R.S.; William Henry Preece, F.R.S.; Sir Robert Rawlinson, K.C.B.; Sir Owen Roberts, M.A., F.S.A.; William Chandler Roberts-Austen, C.B., F.R.S.; Sir Saul Samuel, K.C.M.G., C.B.; with Sir Henry Trueman Wood, M.A., Secretary.

Chicago Exhibition, 1893.

THE EXHIBITION BUILDINGS.

The following Report was drawn up by Mr. Alan Johnstone, Second Secretary in the British Legation at Washington, on his return from a visit recently paid to the city of Chicago, by several Foreign Ministers and Members of the Diplomatic Corps at Washington, on the invitation of the Directors of the Exhibition.

As Sir Julian Pauncefote was unable to absent himself from Washington at the time, Mr. Johnstone accepted the invitation to join the party in his place.

Mr. Johnstone's report was transmitted by the British Minister to the Foreign-office, and the Under Secretary of State has forwarded it to the Society of Arts.

REPORT.

The following are the names of the members of the Diplomatic Corps who accepted the invitation of the Directors of the Columbian Exhibition at Chicago to visit that city, and ascertain the situation of affairs with respect to the forthcoming World's Fair:—

M. Theodore Roustau, French Minister; Senor Don H. Guzman, Nicaraguan Minister; Mr. A. De Claparede, Swiss Minister; Mr. A. Le Ghait, Belgian Minister; Mr. J. Grip, Swedish Minister; Senor Don M. S. Guanes, Spanish Minister; Mr. Ye Cha Yun, Korean Chargé d'Affaires; Mr. Pung Kwang Yu, Chinese Chargé d'Affaires; Mr. Bothine, Russian Secretary of Legation; Mr. Alan Johnstone, British Secretary of Legation; Count B. Batthyany, Austrian Attaché.

The Swiss Minister was accompanied by his attaché, Dr. Alfred Georg, and the Spanish Minister by a secretary, Don M. Multedo, and Captain Don M. del Carre, Military Attaché of the Legation. The Chinese Chargé d'Affaires was attended by Mr. Ho Shen Chee, translator of the Legation.

Colonel Davis, Director-General of the World's Fair, conducted the party personally; and the other gentlemen who joined it at his request were Mr. Sevellon Brown, Chief Clerk, State Department; Mr. A. Allen and Mr. H. Legarre, Secretaries State Department.

The invitations had originally been extended to the Heads of Missions only; but, as several of the Ministers or Chargé d'Affaires were unable to leave their posts, Colonel Davis was kind enough, in those instances, to invite the secretary or attaché of the Legation to be of the party, with the permission of their chiefs.

We left Washington early on Thursday, June 11,

and arrived in Chicago the following morning, where we were met at the station by ex-Senator Palmer, President of the World's Columbian Commission; Mr. W. T. Baker, President of the Executive Committee; and other gentlemen connected with the various committees. We were then driven to the Auditorium Hotel, where rooms had been reserved for us, and, after a short interval, were taken for a drive in Lincoln-park, on the north side of the city, and, subsequently, to lunch with Mr. Medill. After luncheon, we were conducted to the Rand McNally building on Adams-street, where the principal offices of the Exhibition are situated. These comprise the offices of the National Commissioners, of the Local Directory, of the Lady Managers, of the World's Congress Auxiliary, and of the chiefs of the departments, besides committee-rooms, &c. Here we were shown the plans of the Exhibition grounds and buildings, which were explained to us by the chief architect; and we were supplied with a map of the grounds (Enclosure No. 1) and a pamphlet (Enclosure No. 2).

This pamphlet contains detailed information about the Exhibition, under the following heads:—

1. Action by Congress.
2. The President's proclamation.
3. Dedicatory ceremonies.
4. Opening of the Exposition.
5. Foreign exhibits.

With reference to No. 5, I enclose (Enclosure No. 3) copies of the "General Regulations for Foreign Exhibitors at the World's Columbian Exposition in Chicago, prescribed by the Director-General by authority of the World's Columbian Commission," &c.

These regulations, signed by the Director-General, contain all possible information to foreign exhibitors on points connected with the importation of goods into the United States. The circular from the Secretary of the Treasury (also contained in Enclosure No. 3) states that goods destined for the Exhibition will be allowed free entry, and only charged duty when sold. I gathered from the officials at Chicago that Customs officers will be attached to the Exhibition, and that goods destined for sale will have their original price and their price after payment of duty marked on them. I should mention, in connection with the regulations referring to packages, that it has been arranged that all cases containing the goods of foreign exhibitors will be carefully stored away after their contents have been unpacked, so that each exhibitor can, when his goods are removed, either on their sale or at the close of the Exhibition, claim his original case. Complaints were made at the Exhibition of Philadelphia by exhibitors of the expense of providing new cases, as the old ones had, in many instances, been destroyed, and consequently the directors of the Chicago Exhibition have been careful to guard against the recurrence of such a grievance,

Annexed to the regulations is a full list of the classification of the various exhibits under departments and sections.

The remaining heads into which the pamphlet (Enclosure No. 2) is divided are—

6. United States Government exhibits.
7. State exhibits.
8. Awards.
9. Administration of the Exhibition.
10. Plan of organisation.
11. Board of lady managers.
12. Finances.
13. Site for Exhibition.
14. The grounds, buildings, lake pier, &c.

With reference to 10, 11, 12, 13, and 14, I enclose (Enclosure No. 4) a statement in detail relating to these subjects, giving specially full information respecting the finances and the area and site of the various buildings as well of their architectural designs.

15. The Naval exhibit.
16. The Administration buildings.
17. Machinery-hall.
18. Manufactures buildings.
19. Electric and Mining exhibits.
20. Art exhibit.

It was originally intended to place the Art Exhibition on a pier branching out into the lake near the centre of the city, but it has now been decided that the building shall be in Jackson-park, together with the other structures.

21. Light, Heat, and Power.
22. Transportation.

The site of the Exhibition, as can be seen from the enclosed map (Enclosure No. 5), is in Jackson-park, at a distance of about six miles from the centre of the city. The question of the transportation of visitors is therefore a troublesome one, but the difficulty seems to have been fully solved by the managers.

The means of transport are as follows:—

The Illinois Central Railroad which has at present a treble line of rails running towards Jackson-park, and, as explained in Enclosure No. 2, a junction will be effected near the south-west entrance of the park, and these lines run in a loop into a station situated within the boundaries of the park. This treble line will be increased to a quintuple one by the time of the opening of the Exhibition, and I was assured by the transport managers that 150,000 persons could by these means be conveyed hourly from the city to the Exhibition in about 15 minutes. The other means of conveyance are the cable and horse cars as well as ordinary vehicles, which would take about three-quarters of an hour to do the journey, and the steam-boats which will ply from the various piers on the City Lake front to the Exhibition landing stage, taking about the same time, and which will doubtless be greatly patronised owing to the pleasantness of the route.

By these various means it is calculated that over 200,000 people can be transported to the Exhibition per hour. It is thought that the attendance may run as high as half a million in one day, but the average is sure to be far less than this, and consequently there should be no difficulty in conveying people to and from the grounds.

The extra accommodation in the city necessary for visitors to the Exhibition has been carefully provided for. Many new temporary hotels, constructed chiefly of wood, are being built, some in close proximity to the Fair grounds; numerous lodging-houses are also being run up, and it is believed that in these buildings, in addition to the existing hotels, over 300,000 visitors can be comfortably provided for.

On the morning following our arrival we were driven in company with many of the gentlemen connected with the Fair to Jackson-park. We approached it by way of Michigan and Drexel streets, two broad and handsome boulevards bordered with trees, and with beautiful villas standing on each side during the first two miles. Continuing our way through Washington-park (371 acres) we arrived at the Midway Plaisance, a strip of ground 600 feet broad and 80 acres in extent, which connects Washington with Jackson-park (see Enclosure No. 1), north-west corner between 59th and 60th street. Here it is proposed to erect a bazaar for the sale of small articles from Egypt, Turkey, China, Japan, and other Oriental countries. Skirting the Plaisance and the Illinois railway, we arrived in Jackson-park, and at once drove through the northern portion of the park to the lake front, at Pier No. 1 (see map, enclosure No. 1).

Jackson-park (586 acres) may properly be divided into two parts—the northern section between Piers Nos. 1 and 2, and the southern section between Piers 2 and 3. The northern section is already, technically speaking, a park in the strict sense of the term, beautifully turfed and graded, and with many fine trees and pieces of water. A road runs along the park fronting the lake, from Piers 1 to 2, with a sloping stone-paved space between it and the lake. This road will be continued along the whole front of the lake up to Pier No. 3. In the northern section place will be allotted to the State buildings, and the buildings of all foreign nations. The fine arts building (3 acres in area) will also stand in the northern section of Jackson-park.

At present Mexico is the only nation which has applied for space, and one of the best situations bordering on the lake has been allotted to her. The foreign nations and colonies who have accepted the official invitation to participate in the Exhibition are:—France, Great Britain, Germany, Spain, Japan, China, Mexico, Peru, Honduras, Salvador, Costa Rica, Colombia, Cuba, Guatemala, Jamaica, Nicaragua, Chili, San Dominigo, Turkey, Ecuador, Denmark.

Unofficial assurance of acceptance has been received

from Russia, Egypt, Morocco, Venezuela, Brazil, Hayti, and the Argentine Republic.

Messrs. Butterworth, Handy, Lindsay, Bullock, and Peck, have been appointed Commissioners to proceed to Europe and visit the various capitals with a view of explaining the advantages of the Exhibition, and giving any information likely to be of value to exhibitors. This Commission will sail early in July and will stay abroad until September.

Crossing by means of a temporary bridge the piece of water which divides the northern from the southern portion of the Exhibition, we entered the southern part of the grounds in which the main buildings will be erected.* These consist of (see Enclosure 1)—

	Area (acres).
1. Manufactures	31·2
2. Machinery	26·7
3. Agriculture	15·4
4. Transportation	9·3
5. Horticulture	5·7
6. Mines and Mining	5·6
7. Electricity	5·6
8. Government building	3·6
9. Women's building	2·3
10. Fisheries	2·2

The total area of the buildings under roof of this, the main part of the Exhibition, will be over 100 acres. The largest area which has hitherto been under cover in any Exhibition is stated to be 70 acres. We drove about the grounds of the southern section and saw the various spaces destined for the buildings, which were then marked out by flags at each corner. The palisade which forms the boundaries of the grounds on the north-west and south has already been constructed. The wooded island, which is in the centre of this part of the park, is to be left in its natural state, the water surrounding it being made deep enough to allow boats and launches of various kinds to circumnavigate it and convey visitors to various portions of the ground. Three bridges at different points will connect this island with the mainland. Pier No. 3 will extend 1,000 feet into the lake, and at the end of this pier it is proposed to construct a Venetian village, which will contain a casino, restaurant, &c. On the north side of the pier there will be a harbour, formed by the pier, and a breakwater, for pleasure boats, which can pass from there under a bridge into the various pieces of water running through the grounds, which will all be connected with each other.

This southern section was entirely in the rough, though many men were at work on it levelling the grounds, dredging the lakes, and commencing the foundations of the piers. The spaces for the buildings were merely marked out by flags, as I have already said, but all the contracts for their con-

* To illustrate this portion of Mr. Johnstone's report, the proprietors of *Engineering* have been so obliging as to lend the woodcut of the Map on page 730, which is practically a reproduction of the Map referred to by Mr. Johnstone.

Map of
JACKSON PARK
Showing Location of
PROPOSED BUILDINGS
& IMPROVEMENTS.

Fig. 3.



struction have already been let, and on June 24 the first ground was broken. These contracts must all be completed, under heavy penalties, within a year from the date of commencement; consequently it

may be taken for granted that the actual buildings will be in readiness by the 1st of July, 1892. The dedicatory ceremony is to take place on October 12, 1892, and the opening on May 1, 1893.

The foregoing report is chiefly composed of a short analysis of the enclosed documents, all of which contain far more precise and detailed information than I can myself supply. But I have thought it of interest to state from my short personal observation the exact progress already made towards the completion of the Exhibition. There can be no doubt that, as far as the United States is concerned, no effort will be spared to make the Exhibition an unqualified success. Over £6,500,000 will be expended upon it by America alone, and appropriations have already been made by various foreign countries to meet the expenses which will be entailed by their participation. I was much struck by the determination expressed by all the gentlemen I met connected with the Fair, most of whom have voluntarily given their services in aid of it to ensure a triumph. I quote the words of one of them:—"We intend to show the world that Chicago is from her geographical position, situated on the lake as she is, and within reach of the headwaters of the Mississippi Valley, the fittest place on the North American Continent to assemble all our products and manufactures, which as we hope to show foreign nations, are not inferior to those of the rest of the world."

On leaving the grounds we were taken to luncheon at the Club Stand of the Washington Race Park, where during the time of the Exhibition it is intended to have racing every day. We were then driven back to the hotel, and on that evening were entertained at a dinner at which 120 people were present, including all the gentlemen interested in the Fair and some of the foreign consuls. Speeches were subsequently made, and the representatives of the various States of the Union appeared fully as determined as the inhabitants of Illinois are, to do their best to contribute to the success of the Exhibition. On Monday, June 15th, the whole party returned to Washington.

Whilst in Chicago I endeavoured to ascertain what English goods were likely to obtain a ready sale at the Exhibition. I saw several of the leading shopkeepers and manufacturers, and I gathered from them the following information. Nothing but goods of the very best quality and workmanship will find a market, as the Americans can undersell us in the cheaper sorts of manufactures, as well as in agricultural machinery, common sorts of furniture, stuffs, and glass.

The goods which will find customers are, I gathered:—Cheviots, tweeds, homespuns, alpacas, poplins, linen (both table and wearing), weaving, spinning, and mining and machinery. Porcelain (Minton, Derby, and Wedgwood, will find a ready sale); cabinets and the higher class of ornamental furniture, cut glass; cutlery, tiles, jewellery, gold and silver work and fine art in metals; carriages and harness, tapestries and decorative stuffs, mosaics, and stamped leather.

Enclosure No. 3 contains the fullest information

for foreign exhibitors on all points connected with the importation and classification of goods, and, as will be noticed, diagrams of the buildings and grounds will be furnished to the Foreign Commissioners on or before January 1, 1892, indicating the localities to be occupied by each nation, subject, however, to revision and readjustment. The general reception of articles will commence on November 1, 1892, and no articles will be admitted after April 10, 1893.

I regret that, owing to my very short stay in Chicago, I am unable to furnish more detailed information as to the plans and prospects of the Exhibition.

The reason, as stated by the Director-General, for the invitation of the foreign representatives was, that they might assure their Governments that the Columbian Exhibition had fairly started on its way. We have been enabled to see that the site has been chosen and enclosed; that the contracts for the completion of the buildings within a year from that date have been let; that the regulations have been settled; that the various committees have been composed, and are actively engaged in their work; and, according to the statements furnished, the financial arrangements are in the most flourishing condition.

The visiting diplomatists seemed much struck with the energy and determination manifested on all hands in connection with the Exhibition; and agreed that there appears to be every likelihood of the World's Columbian Exhibition attracting numerous exhibitors and visitors from all countries.

I enclose—as likely to prove of interest—(Enclosure No. 6) a Report of the proceedings of the Italian Chamber of Commerce at New York, in relation to the Exhibition, as well as the "Official Directory," which has just been issued.

Miscellaneous.

PERSIAN CARPET WEAVING.*

Carpets are manufactured in many parts of Persia; Isfahan, Shiraz, and Kerman have all a certain fame for carpets; and, similarly, Kermanshah, Yezd, Kashan, and Shushter are known for their cotton *khelims*. The most important manufacture of carpets, however is in North-West Persia, in sundry provinces, with Sultanabad in Irak as the principal centre.

Sultanabad is a comparatively new town, having been built, perhaps, sixty to eighty years ago. In the numerous villages by which it is surrounded, carpet weaving has been the great branch of industry for generations past, although in late years consider-

* This report, prepared by M. G. de Vries, is communicated to the Society by Mr. George Curzon.

able improvements have been made in the class of work produced.

Of the valuable ancient carpets, relatively few are found now-a-days; like curios, the country is pretty well exhausted of them. Persia has been visited by so many European travellers in recent years, that its formerly hidden treasures in the shape of curiosities, &c., have been hunted up out of their corners, and have found their way to European museums or private collections.

It may seem almost incredible to many people that among the ancient carpets, whose manufacture dates back for such a considerable number of years, there are so many to be found that are still in good condition and comparatively little worn. The secret of this is, that not only has great care been bestowed on the weaving of the carpets and on the quality of wool used, but because of the custom prevailing in the houses of Eastern people. Whilst we, with our more civilised ideas, enter our own and other people's rooms with the same boots with which we walk through the muddy streets, a Persian never enters any room, either his own or his neighbours, without leaving his boots or shoes at the door. The Persian carpets of modern times are now so well known in Europe that a more detailed description as to the way in which they are manufactured, may prove interesting.

The weaving is done exclusively by women of all ages. The only share the men take in the work is, that to them the merchants give out the designs (*wagirehs*), the colours, and money required for the weaving. The men also see to the purchase of the wool, &c., and afterwards deliver the carpets to the merchants, getting all the blame for mistakes made in the weaving by their respective wives and daughters. A loom itself is a very inexpensive and simple structure, consisting of four wooden poles, which generally occupy the whole length of the weaving-room. The first thing a weaver has to do when he starts weaving is to buy the necessary material for mounting his carpet and for the warp, the mounting being also a duty allotted to the men. Then he buys his wool and sends it to the dyer, to have it dyed according to the samples given out to him by the merchant. It must not be thought, however, that a weaver, as soon as he has obtained an order for a carpet, hurries home to his village to start it the next morning. There certainly are quick weavers, but they are few and far between. A great many, as soon as they have received the cash advanced to them, spend a greater or smaller part of it on themselves. They buy themselves clothing, pay off debts, gamble, or invest in land, gardens, grain, &c. By the time the carpet ought to be ready the weaver frequently only begins to think of starting it. His speculations often turn out badly, and he finds himself consequently unable to finish the carpet contracted for with the money he has left. However, he buys a little wool to start with and has it dyed, a quantity sufficient perhaps for one-third of the carpet he has to weave. When

this is finished, his resources are probably exhausted, and he is therefore obliged to look out for other means to complete the carpet. His next move is to try and obtain an order for a second carpet from another merchant, of course solemnly declaring that he has no contract for a carpet for anybody else, and promising to deliver it within the stipulated time. He is always, according to his own words, the very best and quickest weaver of his village, and has plenty of reasons to show for happening to be without work just then. Most frequently his excuse for having left his former master is, that owing to a serious (but generally imaginary) illness of his wife, his last carpet was one month overdue, for which interest had been deducted, and he therefore does not wish to serve that master any more. His village being perhaps 20 to 30 miles away, the truth of such statements cannot be determined at once.

Instead of applying to a second master, he also frequently goes to the one for whom he is weaving, and tells him that his carpet is almost finished, that it will be delivered during the next week, &c., but that, as he wants some money for himself, he would be glad of a small advance on account of his next contract! Supplied with fresh money, he then finishes the original carpet. First, however, he must buy the remainder of the wool required and send it to the dyer. The latter is, in most cases, quite as careless as the weaver, and never dyes the same shade of colour twice, the hue being either darker or lighter. The result is that the wool with which the first part of the carpet is woven is of a different shade from the second part; but this can no more be helped, and the carpet is delivered as it turns out, viz., spoiled! This, however, is not the only consequence of the weaver's private speculations. He has to make up for his loss somehow or other, and accordingly buys an inferior kind of wool than that contracted for, gets other and cheaper colours dyed than his samples, and employs less experienced weavers, so as to save something in wages. With his next carpet he deals very much in the same way, and the only means of punishing him is to dismiss him, and to make him pay for the difference in value between the carpet delivered and that contracted for. If he does the latter, he has of course to cheat somebody else first.

Even if we take the case of a good weaver, his work seldom progresses without incessant interruptions. Often the dyer disappoints him by keeping him waiting for his wool; but more frequently his own household affairs put a temporary stop to weaving. His wife has to attend to her baby, milk the cows, make butter, see to the sheep, &c., all of which cause constant delays in the progress of the work.

When weaving is going on regularly, three to four women work at a carpet of fairly large size, the weaver's wife being, as a rule, the principal weaver, and at the same time superintending the work of her daughters or hired women. The rule is, that

at each end of the board on which the women are seated, there should be one female overseer. For carpets of very large size, in the weaving of which seven or eight women are employed, there is also one overseer in the middle. At the age of seven years girls begin already to assist in the weaving; previous to that age, they spend a year or so on the board, watching the other women, so that at an early age they may be accustomed to the work. If a young woman who has been brought up to the loom gets married, the first thing she does is to try and obtain an order for a carpet, so that the weaving of carpets passes down from one generation to another.

People in Europe who buy Persian carpets little think of the enormous labour that has been expended on the weaving. It is done exclusively by hand; and every stitch in the carpet is made separately, being afterwards clipped with the scissors and beaten down. Some idea of the work may be formed, when it is known that, in a good carpet, there are about 10,000 stitches to every square foot!

The clipping and beating down are also very essential points in the work. The clipping, for instance, must be done every time with equal care, otherwise, when the carpet is finished, the pile will be short in some places and longer in others. Upon the beating down depends the closeness of the texture: the more a weaver beats her stitches down the finer, of course, the carpet is. She knows how many stitches she has to weave to every quarter of a Persian yard; but she generally makes less, so as to save wool, time, and trouble. There are carpets, like the cheap Heratis, which have no more than 50 stitches, and 75 stitches at the highest, to every quarter Persian *zar*. Good quality carpets have 85 to 95 stitches, and finely-woven rugs have frequently over 200 stitches. At the latter rate, there would be fully 40,000 stitches to a square foot.

In summer time, when the days are long, the work goes on fairly fast; but in winter it progresses very slowly. When the cold is not too intense, the women have a pot with fire between them when weaving, over which they warm their fingers from time to time, but, on very cold days, they suspend work altogether.

The width of a carpet depends upon the size of the loom, but the length can be made of any dimension. When the weaving has all but reached to the top of the loom, the carpet has to be taken down and rolled up at the bottom, and the work is then started again upwards. The rolled up (finished) part is sewn to the bottom part of the loom, and if this is not done very carefully, the remaining portion of the carpet is sure to "go out"—in other words, the carpet turns out crooked.

There are several European firms engaged in the trade, whose head-quarters are in Manchester and in London. Besides these European houses, a great number of Persian and Turkish merchants export carpets.

When the trade was exclusively in the hands of

native merchants, no other carpets were woven than the ordinary Herati and Shah-Abbas kinds. By introducing new designs, great improvements have been made in this direction by the European firms. These designs, which have been made at great expense and have cost much labour, are their individual property. Weavers have now grown pretty well accustomed to weaving these new designs, but they frequently spoil the effect of them by leaving out part of the original design, and placing something of their own invention in its stead. Even nowadays, nearly all the carpets exported by Persians and Turks are Heratis and Shah-Abbas patterns, with a few very simple designs amongst them. They do not understand the art of designing something novel, but are very clever in the art of pirating the designs belonging to the European firms. Formerly there did not exist any law against this pirating of designs, but as in recent years this evil grew worse and worse, the Persian Government, through the influence of the British Legation at Teheran, have at last, at the commencement of this year, acknowledged the right of property of designs, and the copying of them is now strictly prohibited.

In addition to designs, the shades of colours employed in the carpets are a matter of vital importance, requiring the most careful attention, since they must be in harmony with the ever-changing taste of European markets. At present, entirely new colours are the rage, which give a carpet more the appearance of an antique than of a new one; but it is certain that the taste for these fancy colours is only a passing one, and the sooner people return to the former colours the better. Aniline is still greatly used in the dyes by the native merchants, but carpets woven of such colours should be entirely avoided, as the colours fade away after a time.

Besides woollen carpets, rugs are exported, woven entirely of silk. The weaving of such rugs is done in the same way as the weaving of carpets, but the labour is far greater in proportion, as they are always of a very fine make. Such rugs can be used as table and sofa-covers, *portières*, &c., but, as they are made of pure silk, they are very costly.

Altogether, it will be seen from the foregoing that the Persian carpet business is far from being a bed of roses. From all points of view the trade is a most difficult one; and long experience, and a thorough acquaintance with the weavers and their ways, are necessary to surmount some of the numerous obstacles.

The districts where carpets are woven are Ferahan, Muscabad, Japelag, Kezaz, Cherreh, and Saraband, comprising in all about 150 villages, with a total number of looms, estimated at about 5,000. The quality of carpets which these looms produce varies according to the districts. Most of the above districts produce only second and third quality work. In two of the largest, however, a fair proportion of the looms produce first quality carpets.

In some of the looms as many as five to six hands are employed, but this is rather an exception. The average is three weavers to a loom of fairly large size, one and two weavers for small looms; so that, if all looms are engaged, close upon 1,000 hands would be employed. A fast and steady weaver could deliver annually three to four carpets of ordinary size; but a large number only weave at intervals, and slow weavers take sometimes eighteen months to two years to finish one carpet. The irregular weaving makes it, therefore, impossible to give anything like a reliable estimate of the annual output or export value.

THE JAMAICA EXHIBITION.

BY FRANK CUNDALL.

The Jamaica Exhibition finally closed its doors on the 2nd of May, at a date when similar institutions in Europe were holding their opening ceremonies.

Like many of its predecessors, this undertaking soon far outgrew the dimensions contemplated, when it was first projected in July, 1889, by Mr. Fawcett, during his chairmanship of the Institute of Jamaica.

Jamaica has, in the past, taken part in various important exhibitions; in 1876, at Philadelphia; in 1883, at Amsterdam; and at the Fisheries Exhibition in London; in 1884-85 at New Orleans; and in 1886, at the Colonial and Indian Exhibition. And the holding of the present Exhibition will in no way have made her less inclined to join in the gigantic gathering which America promises to inaugurate in Chicago in 1893, to participate in which she has recently decided on the representations made by the Special Commissioner for the West Indies, Mr. Frederick Ober, the well-known author of "Travels in Mexico." Nor will she be the less ready to prepare for her own celebration of the fourth centenary of the discovery of the island. A fitting memorial of this celebration would be the placing of a statue of the great discoverer, Columbus, on the pedestal—now empty—which stands at the foot of King-street, a striking evidence of the perseverance of the people of Spanish Town, who caused the statue of Rodney to be returned to them in 1889, after a sojourn of sixteen years in the present capital.

The history of the Jamaica Exhibition since its opening, ran parallel to that of many a similar venture in other countries. It had its warm supporters, and but few depreciators—the former actuated by praiseworthy and characteristic patriotism, the latter possibly by misconceived ideas of the objects aimed at by the promoters of the Exhibition.

The total attendance for the eighty-two days during which it remained open was 304,354, or a daily average of a little more than 3,700, a very satisfactory result when the total populations of Kingston and the whole island—now estimated at about 40,000 and 620,000 respectively—are taken into account.

The cause of the difficulty in inducing some of the black population to visit the Exhibition—a fear that it was a trap whereby to sell them into slavery again—is almost incredible to European minds, but it is none the less true. And in more than one case the fear was allayed only to re-awaken at the sight of the turnstiles, clearly showing that education and civilisation have an uphill work to perform before some portions of the native population shake off all trace of "Obeah" and similar superstitions, and an ignorance begotten of centuries of slavery.

However, mainly owing to the "Message to the People," which the Governor caused to be widely disseminated at an early stage, and partly to the efforts of the rural clergy and others, a large portion of the country people have now visited Kingston, and have taken home with them something of the wonders they have seen, even if their chief reminiscences will be of the fireworks, the performing seal, the skating-rink, and "Amphitrite," or of the joys of the steam merry-go-round, on which many of them spent the larger portion of a week's wages. Facility was given to schools to examine the exhibits by the granting of admission to them at reduced rates; and inducement to visit the building culminated in a liberal offer on the part of the Governor to defray an average Friday's receipts, and throw the Exhibition open free to all classes, an incident without parallel in the history of exhibitions. The order and appreciation of the crowd of nearly 30,000 visitors who passed the turnstiles on the 24th of April ("Governor's Day") must have been sufficient reward to Sir Henry Blake for his generosity.

The building is of a neo-mauresque style of architecture, cream colour and Indian-red in tone. The internal arrangements are similar to those of all other exhibitions, and present no new features.

It is a matter of regret, in the interest of both Jamaica and the West Indies generally, that many of the other West Indian islands either held aloof, or were poorly represented, and that so few of the inhabitants of the sister islands responded to Jamaica's invitation to visit her shores. Had the British West Indies combined in Kingston in the same way as they did under Sir Augustus Adderley in London in 1886, but on a larger scale, and with greater fulness rendered easy by the fact that the Exhibition was held in their midst, they would have been able to convince visitors of the importance of this portion of the British Empire. As it is, the island best represented was undoubtedly St. Vincent, which besides sending a full collection of native woods, sugar, arrowroot, cacao, starches, nutmegs, and other spices, preserves and rums, fibres, fishing apparatus and basket work, also prepared a useful handbook. Next must be mentioned Barbados, the Clapham Junction of the West Indies, famous for its sugar, which sent examples of its raw products and manufactures; while the Bahamas, with their shells, sponges and corals, and the Pita fibre to which they owe much of their present prosperity; Grenada, which now

flourishes on cacao and nutmegs; and St. Lucia, which remains true to sugar; all contributed small but representative collections.

Of great interest to Jamaicans were the courts of the two dependencies of the island, the Turks and Caicos Islands, of salt-producing fame, and the Grand and Little Cayman, the home of the turtle fisheries—the former lying to the north of Haiti, and the latter some 150 miles to the north-west of Jamaica.

Jamaica did not do herself justice. In no international exhibition did the country holding it reserve so small a space to herself. Of her products, the principal were coffee, cacao, rice, starches, fibres, meals, tobacco, spices, and preserves, while the once powerful sugar is comparatively poorly represented. A few rustic seats, with backs carved out of the solid roots of cedar trees of unusual size, about six feet in girth above the buttresses, were much admired. The wood is well seasoned, as the trees had been felled twenty years when the seats were made. Several good examples from this court have been presented to the Institute of Jamaica, to which body has been entrusted the work of preparing a collection of Jamaica products for the Imperial Institute.

The Institute of Jamaica, which was founded during the Governorship of Sir Anthony Musgrave, in 1879, for the encouragement of literature, science, and art, gathered together in its court a collection illustrating these main objects. Literature was represented by books on Jamaica, dating from Hickerin-gill's account of the island, published in 1661, to Thomas's "Untrodden Jamaica" of the present year, the author of which has been the first to explore the almost inaccessible peaks of the John Crow Mountains. The science collections contained examples of building stones, clays, ochres, and marbles, specially gathered from all parts of the island; a complete collection of the land, fresh water, and marine shells of Jamaica contributed by Mr. Henry Vendryes, as well as examples of zoology, and various maps of great interest. A map comparing the sugar estates of 1790 with those of 1890, indicates the changes which have taken place during the past century in the cultivation of the soil, and the location of the people. The labouring classes, at one time tied by force of circumstances to individual estates, now overrun at will the whole island. Now each man can, if he will, cultivate his own plot of coffee, bananas, or other crops; and in course of time—if they can only rid themselves of a certain disinclination to continuous labour, the result of a too easily earned competency—a peasantry may grow up as thrifty as that of France. The recent resolution of the Legislative Council to devote funds to the technical instruction of the people in matters of agriculture cannot but tend to that end.

Amongst the archæological treasures of the Institute were some papers of an American brig, the *Nancy*, which were found in the maw of a shark caught off Jacmel, in 1799, and which led to the

condemnation of the brig and her cargo at Kingston. Were it not for the formal declaration of the lieutenant of the British man-of-war who found them, duly attested by the surrogate of the Vice-Admiralty Court, one would be tempted to put the story down as no better than many another yarn told with it in "The Cruise of the *Midge*." A piece of timber from the *Alabama*, cut out of her in 1864, when she put into Port Royal after her memorable victory over the United States' gunboat, *Hatteras*, off Galveston, had special interest, as the *Kearsage*, which sunk her off Cherbourg a few months later, entered Kingston harbour during the term of the Exhibition.

It will be remembered that, during last year, an idea was started in England that Cromwell's "bauble" went to Jamaica after its disappearance from Westminster, and that it is still preserved there. The only two maces in the island were exhibited by the Institute, in whose custody they were placed in 1879. They are both silver-gilt, and stand about 5 feet 6 inches high. They both bear the British arms in use from 1714 to 1801. Round the head of each are the emblems of England and Scotland, of Ireland, and of France, and the arms of Jamaica. One or the other was used by the old House of Assembly, and also in later days by the Privy Council. In one, the arms of Jamaica have evidently been added after the mace was manufactured, tending to prove that it was not made for the island. The curious part is that hitherto no record has been found of maces having been sent to Jamaica at or after the date indicated by the hall-marks.

The only entries with reference to a mace for Jamaica in the 17th century are the following. On page 35 of the Appendix to the volumes of the "Journals of the House of Assembly," being copies of commissions and instructions to governors, &c. (A.D. 1671, Sir Thomas Lynch, governor), we read:—"His majesty has been pleased to favour this island with a mace, that cost near £80, which is carried before the governor on solemn occasions, as a mark of his authority."

At the same time, Charles II. sent "a great seal of silver, wherewith all commissions, patents, and public acts are sealed." This seal bore, *inter alia*, the motto *Indus uterque serviet uni*, the adopted motto of the island.

Again, on page 46 of the same Appendix (A.D. 1683, Sir Thomas Lynch, Governor for a second term) we read:—"The King has been pleased to honour this island with a large gilt mace, as a signal mark of his favour, and to make the government appear more great and formal. It's carried before the governor and chancellor on solemn occasions."

And reference is again made to "a public broad seal" with the above-mentioned motto, and the entry goes on to say: "All this as I have heard, was designed by the present Lord Archbishop of Canterbury, in the year 1661," *i.e.*, William Sancroft. If the "bauble" ever came to Jamaica, it probably perished in the destruction of Port Royal in 1692.

Amongst foreign nations and British colonies, the palm must unquestionably be accorded to Canada. Thanks to the energy of the Honorary Commissioner, the Hon. Adam Brown, the Dominion placed forcibly before the people of Jamaica, those wares and products which she can offer on advantageous terms, such as furniture, agricultural machinery, flour, timber, and especially cheese and butter. Free distribution of cakes and bread, made from Canadian flour, frequently took place, and other means were adopted to popularise Canadian manufactures with the people of Jamaica.

The largest cargo of fish and manufactured goods, especially ready-made clothing, and beers and spirits, that ever entered Kingston harbour from Canada, since a subsidy was voted to the steamship company trading between Halifax and Jamaica, was that which reached Kingston just before the close of the Exhibition, and this increase is said to be directly traceable to Canada's participation on the present occasion.

Although the United States was not represented as a nation, yet a court filled with New England goods, with Mr. T. T. Stokes at its head, proved that much may be done by co-operation without State aid. Here were placed many articles of furniture and other objects, illustrating the inventiveness of the American mind, and the fact that utility is always kept in view in American manufactures.

As both Canada and the United States offer practically unlimited fields for the export of Jamaica fruits, great interest attaches to the participation of these two countries in the Exhibition; and from this participation probably the greatest good will result, the more especially as there are indications that Jamaica would be—if fit arrangements were made for easy and frequent travelling, and for the reception of strangers—visited by increasing numbers from Canada and the United States, who would be glad to escape the severity of a northern winter. Those who have visited the island have taken home with them pleasant recollections of their stay, and many have expressed their intention to return. With this condition of affairs in view, the aid afforded by Government to the hotels of Jamaica seems both wise and well-timed.

Austria, Italy, France, and Germany sent examples of art manufactures, such as pottery, glass, statuary, and furniture, which have been intimately associated with their respective sections at exhibitions during the past few years, but which are, of course, new to the West Indies. Of greater interest to European and American visitors were the intelligent Caribs from St. Vincent, the last remnants of a warlike race which caused much trouble during the closing years of the last century. They still live at Morne Ronde, where land was granted to them in 1805, and at Sandy Bay and Greiggs, and carry on their trades of basket-weaving and fishing in a peaceful manner, which has little in common with the habits of their warlike forefathers. Their process of basket-weaving

is most interesting. The baskets—which are, perhaps, without rivals for durability in the world—are rectangular in form, and are woven so deftly and padded so neatly that they are waterproof, and the smaller ones will actually hold water. They are woven of the celebrated *reuma* (the Carib name for a species of cane which grows in St. Vincent and elsewhere to a height of 15 or 20 feet without joint or knot, and with a tuft of leaves at the top) and the *roseau* or wild cane. The baskets are padded externally with leaves of the *ballisier*, or wild plantain, and then a second basket is imposed over this padding. A similar basket is made as a top, and thus each basket really consists of four.

The Caribs also manufactured at the Exhibition specimens of their fishing lines of the *gree-gree* and *lapite* palms, made by rolling the fibre on their legs.

For the first time in the history of the island, a potter's wheel was seen at work, and, in the near future, the antiquated and uncivilised method of moulding jugs and basins from plaster moulds will give place to their formation on the wheel. The working potter who came over from England reported so favourably on the clays of the island that, in all probability, a new industry will be created.

A sugar mill, shown by an American firm, and another from Glasgow, were improvements both in quality and price on the form commonly used by the cane-grower, and will probably materially assist the small planter to make larger profits from his "cane-piece."

For many years the question of a suitable machine to treat the fibres of Jamaica has engaged the attention of the Government. A premium was offered for the best machine, and one of those sent seems likely to meet the requirements of the case.

During the course of the Exhibition lectures were given, under the auspices of the Institute of Jamaica, upon subjects of interest to Jamaicans. The Hon. Dr. Phillippo, the leading authority on such matters in Jamaica, read a paper on "The Mineral Springs of the Island," which showed that Jamaica possesses in Milk River and "St. Thomas the Apostle" baths, which for medicinal properties will hold their own when compared with those on the continent of Europe, and that they only require additional expenditure to make the accommodation better in order to attract a considerable number of visitors and seekers after health. Dr. Calder read a lecture on "The Cultivation of Rice in Jamaica," which industry he introduced some years ago, and which he showed was susceptible of development with profit to those engaging in it; while Mr. Adam Brown impressed upon his hearers the advantages to be gained by extended trade relations between Canada and Jamaica, and Mr. Ober pointed out the wonders that might be expected at the Chicago World's Fair.

It is perhaps to be regretted that a carefully prepared guide-book, written in a popular style, easily understood by the masses of the people, had not been issued. Had this been done, it is possible that

additional educational results might have followed; for it requires some experience in exhibitions to be able to pick out readily the salient features amongst a mass of less instructive, if more attractive, objects. But this is a small matter; and the wonder is, how an exhibition, so perfect in many respects, should have been organised and carried out by those who had but scanty opportunities of gaining experience in such affairs, and who leant but slightly on extraneous aid.

By means of this Exhibition, it is hoped that Jamaica may have been brought to notice as a field for emigration from Britain and Canada. There are numerous openings for young men possessing moderate capital of say from £2,000 to £3,000, and, if possible, some knowledge of agriculture.

At present, there is in the island much land which could readily be devoted to stock-raising; and bananas and coffee-planting offer inducements for the investment of capital.

But many are deterred from entering on an agricultural career in a foreign country from the knowledge that to start without some preliminary experience of the country and of the conditions under which business is conducted, is to court disaster. With this idea in view, the Institute of Jamaica has in contemplation the preparation of a "Register of Planters and Pen-keepers" who would be willing to take articulated pupils, which register would be sent to emigration offices and other sources of information in England.

Had it not been for the unfounded dread which unfortunately prevails in England of the supposed unhealthiness of the Jamaica climate, it is possible that many seekers after health from the old country would have visited the island during the winter of 1890-91. As it is, the disappointment expressed by some Jamaicans at the small number of visitors from England, arose, it would appear, from expectations which were not altogether justified.

The usual question has of course been asked, "What shall be done with the buildings?" and schemes have been suggested for the guarantors to take them over, and maintain them as a kind of Crystal Palace or People's Palace—schemes which are, it would appear, based on Utopian theories as to the capabilities of a town of the size of Kingston to maintain such an institution in perpetuity as a paying concern.

On the other hand, suggestions which have been made for the maintenance of a small portion of the building and of the grounds, are, it would seem, worthy of consideration and support.

THE PREPARATION OF MACARONI IN ITALY.

Macaroni is the *semoule*, or flour of wheat, moistened with water, kneaded until it assumes the requisite consistency, cut or pressed into the desired

shape, and thoroughly dried. When wheat flour is agitated in a large quantity of water, the starchy substances are dissolved, leaving a tough fibrous mass, which is gluten. Gluten contains nitrogen, while starch does not; hence the *semoule* or flour that contains the most gluten is the most nutritious. As compared with gluten, starch has but little strength: hence macaroni, that is rich in gluten, is not only the most nutritious, but is stronger, thereby preserving its shape while being dried and cooked. The United States Consul-General at Rome says, that for the best macaroni, the hard, semi-translucent varieties of wheat grown in warm countries, which contain a large proportion of gluten, are used in the form of *semoule*; for the cheaper grades common flour is used. Any intermediate grade can be made by mixing the two in various proportions. There are no statistics giving the quantity of macaroni made in Italy; but, as it constitutes one of the chief articles of food, the quantity must be exceedingly great. There are many large establishments manufacturing it by steam-power, and probably many thousands worked entirely by hand-power, and employing from three to five or six hands each. It is also an article of daily household production in a large proportion of Italian families. In the household the appliances are exceedingly simple—a smooth board, a piece of marble for kneading, and a common rolling-pin. One pound of flour is mixed with four or five eggs, moistened with hot water, kneaded a few minutes, and then rolled out very thin with the rolling-pin. After drying on the kneading-board for fifteen or twenty minutes, until the surface loses its adhesiveness, it is rolled up tightly, and thin slices are cut from the ends. The slices falling apart constitute strings of macaroni, and are ready for use. The macaroni factory, which is worked by hand, often consists of but one room, exclusive of the drying-rooms. The proprietor, with one or two workmen, makes the macaroni, and the wife sells it. The machinery is inexpensive, and the hired labour costs from 1s. 3d. to 2s. 6d. a day, according to the locality. Artificial heat is seldom employed for drying, but the manufacture is often carried on in connection with the baking business. In this case, the drying-rooms would be above the ovens, and warmed somewhat by the waste heat. The result is, that these small establishments can successfully compete with the larger factories that are worked by steam-power. Their machinery generally consists of a mixer, a kneader, and a press. The mixer may be described as a semi-circular trough, having a hinged cover. Through the trough runs an iron shaft, having a number of projecting arms, with a crank on one end. About 100 lbs. of *semoule* or flour, or a mixture of both, according to the quality of the macaroni desired to be produced, is placed in wooden troughs, that stand in front of the mixer. To this is added a sufficient quantity of water, at about 160° Fahrenheit, containing, in solution, a small quantity of saffron, to give the macaroni the desired colour. It is then

mixed by hand for a few minutes, in order to fairly distribute the water, after which it is put into the mixer. The lid being closed, a workman turns the crank for about twenty minutes, when the contents are found to be converted by the action of the arms attached to the crank shaft, into a stiff dough. From the mixer the dough is taken to the kneading-table. This is made in a number of ways. One of the most common in the neighbourhood of Rome consists of a kneading plank about 40 inches long, 32 inches wide at the inner end, and 40 inches at the outer end, with sides to keep the dough from falling out. It is solidly made of hard wood $2\frac{1}{2}$ to 3 inches thick, and firmly attached to the floor and wall. The kneading is generally done by two or three men with a long bar attached by a swivel joint to the wall at the back of the table. This bar is about 16 feet long, 10 inches deep next to the wall, and 3 inches at the other end. The part next to the dough is bevelled to the shape of a blunt wedge with a rounded edge. The bar is worked up and down on the dough, and being fastened at the end exerts a tremendous and crushing force. Being made of a tough, elastic wood, it both readily sustains the full weight of the men when pressed down, and springs back above the dough sufficiently to allow it to be moved a little, and brought down on another part. This kneading continues for about twenty-five minutes, when the dough is ready for the press. In some places the table is a straight plank about 8 to 10 feet long and 15 inches wide, with sides to hold the dough in position. The kneading is done by means of a drum about 4 feet in diameter, and the width of the plank. It is worked backwards and forwards by means of an upright capstan, about 12 inches in diameter, with a rope coiled round it and around suitable mechanism on the drum. As soon as the dough is in a suitable condition, it is taken to the press, which consists chiefly of a cylinder about 8 to 10 inches in diameter, and 20 to 24 inches long, a plunger that fits the interior accurately, and a die plate that rests on a shoulder cast on the lower portion. The plunger is forced down by a screw, which is suitably connected by working with a crank by hand. While one man mixes the dough, another turns the crank to press it, and the third takes the macaroni as it leaves the dies, cuts it into suitable lengths, and hangs it on light cane or bamboo sticks about 5 or 6 feet in length, ready to be carried to the drying-room. The press is heated to about 160° Fahr. by means of a small pot of live coals, which is placed inside the cylinder a few minutes before pressing begins. From the presses the long macaroni is carried on light bamboo sticks to the drying-rooms. The small and fancy shaped are dried on screens. These are wooden frames about 2 feet by 6, covered with a coarse cloth, so as to allow the air to freely circulate. A brace across the middle of the frame serves as a handle. The small and fancy dried macaroni is made in horizontal presses. Cutters revolving more or less rapidly near the face of the die, according

to the length required, cut it into any desired length. The speed of the cutters is regulated by a pair of cone pulleys. The drying of the macaroni is the most difficult and delicate part of the manufacture, and depends much upon the state of the atmosphere. It is first dried in the open air, the time in the sun or shade depending on the temperature and dryness of the atmosphere, from half an hour to three hours, the time also depends to some extent upon the size of the macaroni. It is then carried to a close damp room, where it remains about twenty-four hours. If the room is not sufficiently damp it must be kept so by artificial means—by small steam jets or by the evaporation of water. It is sometimes covered with cloths during this stage to prevent drying too rapidly. The rest is a retarding process, and is intended to prevent the surface of the macaroni from drying too fast, and to allow the interior to harden. If the macaroni is not allowed to rest at this stage, it is liable to crumble or split. From the resting rooms it is carried to large spacious rooms that have thorough ventilation, either natural or artificial. It is estimated that for each man employed in the steam factories, about 170 to 200 pounds of macaroni are produced per day.

General Notes.

THE LOFODEN COD FISHERIES.—The British Consul-General at Christiania, in a recent report, says that the habits of the fish and the way in which they were caught differed entirely from the previous year. At the commencement of the season the cod showed signs of restlessness, and not only kept near the surface of the water, but travelled up the fiords. The result of the fishing was the unusually large catch of 31,000,000, and the quantity both of liver and row was very great. Last year the catch was only 18,000,000 fish, and the total value was £416,500 this year against £141,511 in 1889. Of the enormous catch this season, 27,400,000 fish were prepared as split cod, and 3,600,000 were dried. Attempts were made to prepare the fish in other ways, but a factory for preparing pressed cod was destroyed by fire. The mild weather prevented the despatch of fish to distant places. There were 30,324 engaged in fishing, each man caught an average of 1,022 fish, and got £13 12s. 3d.; but, in fact, the profits were most unequally divided, some men who were fortunate getting £42 to £44, while others got from £6 13s. down, in a few cases, to only 11s. 3d., for 100 days' work. The total value of all Norwegian fisheries last year was £766,600.

Journal of the Society of Arts.

No. 2,019. VOL. XXXIX.

FRIDAY, JULY 31, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

THE ALBERT MEDAL.

The Council of the Society of Arts attended on Monday last, the 27th instant, at Marlborough-house, when His Royal Highness the Prince of Wales, President of the Society, presented to Mr. W. H. Perkin, F.R.S., the Albert Medal, awarded to him in 1890 "for his discovery of the method of obtaining colouring matter from coal-tar: a discovery which led to the establishment of a new and important industry, and to the utilization of large quantities of a previously worthless material;" and to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., the Albert Medal for the present year, awarded to him "in recognition of the manner in which he has promoted several important classes of the arts and manufactures, by the application of chemical science, and especially by his researches in the manufacture of iron and steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as chemist of the War Department."

The Members of Council present were the Attorney-General, M.P., Chairman; Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Deputy-Chairman; W. Anderson, F.R.S.; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.; Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E.; Prof. James Dewar, M.A., F.R.S.; Major-General Donnelly, C.B.; Sir Henry Doulton;

Sir Douglas Galton, K.C.B., D.C.L., F.R.S.; Thomas Hawksley, F.R.S.; Sir Robert Rawlinson, K.C.B.; Sir James Douglass, F.R.S.; Michael Carteighe; Francis Elgar, LL.D.; J. Biddulph Martin; W. H. Preece, F.R.S.; W. C. Roberts-Austen, C.B., F.R.S.; Sir Saul Samuel, K.C.M.G., C.B.; and Sir Owen Roberts, M.A., F.S.A.; with Sir Henry Trueman Wood, Secretary of the Society.

CHICAGO EXHIBITION, 1893.

Forms of application for space, and prospectuses with detailed information, will not be issued till October, but, in the meantime, intending exhibitors can apply to the Secretary of the Society of Arts, and their names will be noted at once, with a view to their receiving early copies of the prospectus when ready.

Proceedings of the Society.

CANTOR LECTURES.

MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.

By A. J. HIPKINS, F.S.A.

Lecture I.—Delivered January 26th, 1891.

The inquirer about musical instruments, who turns for information to established works upon instrumentation, will find his curiosity about their construction and development unappeased, as the musician's point of view is directed solely to the use he can make of them. If he turns to musical dictionaries or technical works he will still remain unsatisfied because the information is, for the greater part, supplied in a fragmentary form. The intention of these lectures is to explain the construction and capabilities of musical instruments from a more general aspect; briefly, it must be, as in three lectures there is not time for a detailed study. I can only sketch the outlines of a work.

I will begin with the various stringed instruments—whether they are touched, twanged, or bowed to produce their sounds—that have been used in modern European music; continuing with the various wind instruments,

wood or brass, whether blown by the lips by means of a single or double reed, by a whistle or a mouth-piece; also the drums and other percussion instruments; and, lastly, gathered for the sake of convenience into a separate class, the instruments played with an intermediary keyboard, borrowing from the wind the organ and harmonium, and from the stringed division the piano.

Of the stringed instruments, the violins are the first in importance, whether it is for power and delicacy of musical expression, fitness for exact intonation, or arriving at structural perfection almost at once, since no change has taken place in the violin from its invention 350 years ago; and apart from its musical value, a well-made violin is in form, and often in colour, a never tiring enjoyment to the eye. It is the sum of these fine qualities that justifies the pre-eminence always accorded to the violin family. But in praising the instrument the bow must not be overlooked, as it is indispensable for the production of the tone, and is the means by which the player can impart his personal musical feeling, and take a part in reproducing the masterpieces of the modern masters of chamber music and the orchestra. Unlike the violin, which has changed so little, the bow was improved by degrees until about 100 years ago, when it was fixed and made perfect by the beautiful contrivance of Tourte.

The invention of the violin is attributed to Gasparo da Salo of Brescia, about the year 1550. There is no certain evidence about the instrument it may be supposed preceded it, and was also tuned, like the violin, in fifths. It may have been a German instrument altered by Italian taste. Attribution to Gasparo da Salo lacks positive evidence, but it seems to be warranted by his place in the order of time. Almost immediately after we find Maggini, the greatest of the Brescian school of violin makers, and Andrea Amati of Cremona, the latter supplying the French King, Charles IX., with violins in 1572. Amati founded the school of Cremonese violin making, which has been universally accepted as pre-eminent. It culminated in the supreme achievements of Stradivari and Guarneri del Gesù, in the early years of the 18th century.

The size and proportions of a violin are exactly calculated for a player's arm and convenience, and the lightness of the instrument (for a fine violin weighs, when fitted and strung, only from three-quarters of a pound to a pound) is as remarkable as the expressive

character and the energy of the tone produced. In the best patterns, excluding the neck, it is not more than 14 inches long, and at the widest part it hardly exceeds 8 inches. The strain of the four strings in the present day depends, of course, upon the thickness and corresponding weight of the stringing. With a heavy stringing it has been given by Mr. George Hart as 62 $\frac{3}{4}$ lbs., and with a light stringing 52 $\frac{1}{2}$ lbs., the downward pressure upon the bridge being 27 lbs. 13 $\frac{1}{4}$ ozs. and 23 lbs. 5 ozs. respectively; at the modern Philharmonic or English Orchestral pitch of 452.5 double vibrations per second, for A, the open note of the second string. But I am not sure that Mr. Hart took into consideration the height of the bridge, which adds to the tension more or less. The first string is tuned a fifth above this A, and bears the greatest strain; hence its penetrating tone-quality and also its liability to break. The third string, which should be the most mellow and full in tone-quality of the instrument, is tuned a fifth below the second. All these three strings are of gut, and selected from the small intestines of sheep, prepared by a long and very careful process to separate them into threads. Three or four of these threads are spun for the first and second strings, and six or seven for the third. The fourth string in a violin is a covered string, that is to say, it is of gut spun over with fine silver or copper wire; the loading of the string is to increase the thickness and weight, so as to make the rate of vibration slower. The accordances are thus: G below middle C, D, and A in the octave above it, and E above C in the treble clef. The strings being all of the same length, have to be made gradually heavier in the order of second, third, and fourth to obtain this accordance. Although these strings are less strained than the first, the making up by thickness is essential as well for the fulness of tone as for the tension required. It will therefore be seen that, owing to these conditions of uniformity of length and the difference of thickness and tension, the violin, with all its merits, is far from being a perfect instrument, as may be heard when a player has the misfortune to break the first string, and continues with the second for his highest string.

We will now regard the bridge, belly, and back, the sound-post and bass bar. The violin is a resonant box built entirely of wood, no metal of any kind properly entering into its structure. The back is of a hard wood, frequently maple, and is usually in two pieces

joined down the middle, but may be in one piece. The belly is of a soft wood, spruce fir (*abies excelsa*), chosen with a fine regular grain suitable for uninterrupted vibration, and dried by long exposure to the air. This is also usually in two pieces, although it may also be of one. Spruce (when cut commonly known as deal) is the best resounding wood on account of its slight density and uniform elasticity. The function of the belly is to reinforce the sound initiated by the strings, in accordance with the law by which all substances capable of a certain rate of vibration, will respond to that rate sympathetically whenever submitted to its influence; the distance being not too great for communication. The strings, which, from the way they are agitated, vibrate transversely, or across, when in motion, offer too little surface to affect the surrounding air to become more than very feebly audible. But their vibrations, carried through the bridge to a much wider superficial expanse of wood which is called the belly, are largely increased or reinforced, as is well known of all stringed instruments furnished with sounding or resonance boards. Wood, and particularly firwood, is a very much better sound conductor than atmospheric air. To illustrate the power of resonance, it will be sufficient to compare a practising or dumb violin that is sometimes made without resonance box, and a real one. The wood takes up the sound of the strings with all their proper tones, to the very smallest vibratory movement as well as the most complete harmonic combination, exactly the same as the atmospheric air, and no more. Thus all vibrations and figures, however complicated, initiated by the friction of the bow upon the strings, are transmitted to us from the wooden box, and completely, if not impeded or quenched by any imperfection in the wood, through the ever-faithful environing air. Suppression of the original force imparted by the player from the exhaustion of energy, and the all-compelling power of gravitation, is nearly instantaneous, a sustained tone being only maintained by the bow.

The back and belly of a violin are connected by six strips of maple, technically called ribs or sides, which complete the framing of the resonance box. They help to transmit the vibrations of the belly to the back, and are attached by means of glue. The curvature of the sides was early introduced in a precursor of the violin, to enable the bow to pass easily across the strings. It divides the shape of the

instrument into what are technically called the upper, middle, and lower bouts. Both back and belly are vaulted more or less in opposite directions, according to curves which have been empirically determined by the influence this vaulting has upon the tone. It also offers a certain mechanical resistance to the strain and pressure of the strings. But the building up is materially assured by the blocks—six small pieces of spruce, or it may be of lime or willow, shaped and glued into the instrument: four at the four pointed corners of the C's, or middle bouts, one at the top, and one at the bottom. They are set perpendicularly as regards the grain. There are also twelve strips of spruce, lime, or willow, called side linings, which connect the blocks together, and bind the resonance case into a homogeneous structure. The dark lines round the edges of the back and belly, apparently ornamental, are called purflings, and are inlaid in 24, sometimes 36 pieces. The *ff*, or sound-holes, are very noticeable features in a violin. Their shape is due to the vaulting of the belly, and, like the vaulting, varies with the intention or fancy of the maker. They are characteristic of the violin family from its origin. They are cut symmetrically, on either side of the bridge, and their first intention appears to have been to give readiness of response—technically, speech—to the belly. They weaken it, to a certain extent, as the pressure of the bridge comes between them; but that loss is made up by the resistance of the sound-post and bass bar. It is also a feature of the sound-holes that vibrating air contained within the resonance box escapes through them. This air is set in vibration by the wood which encloses it, but has a shape or form of vibration determined by that of the instrument. If the sound-holes are too large, the pitch of this air rises, and the tone of the instrument becomes shrill; if too small, the pitch flattens, and the tone becomes dull. So the shape, size, and position of the sound-holes are clearly no more arbitrary than anything else in a violin. By a happy disposition the proper note of a violin, as a resonance box, behaves as a general reinforcer, helping any note that happens to be played. The late Dr. A. J. Ellis and I made several trials of good violins by means of tuning-forks of various verified pitches, in each instance proving this curious fact. The maximum of air reinforcement was found to be about C in the *treble clef*, at a medium pitch, reckoned at 528 double vibra-

tions per second, an approximate mean between the Paris normal, and the London Philharmonic or Kneller Hall pitches (C 517·3, C 538). The bridge is of maple with horizontal grain and of medium hardness, and should be about half as thick at the top as at the feet. Its peculiar design, apparently arbitrary and proceeding from the workman's taste, is really an empiric cutting presumed to have been fixed in its present form by the great Stradivari, and to depart from it ever so little in any direction is found to be prejudicial to the tone. Bridges have come down, however, of the Amatis, which are nearly of the same form. The adjustment of the bridge, as indeed every part in a violin, is of the greatest importance. If it is too thick the tone becomes dull and difficult to produce; and if too thin the tone becomes shrill and disagreeable. It must be remembered that the higher the bridge the greater is the tension, and that the height has to bear a certain relation to the thickness of the belly, all very nice points that only the greatest skill can deal with successfully. The feet of the bridge have to fit the vaulting of the belly. The top is rounded to prevent the bow touching more than one string. It would seem that the bridge being cut out across the belly, and resting upon the feet, is due to the centre line along the belly where the wood joins, or even if it is in one piece, being a node—that is to say, a line of no vibration, but at the same time a line of maximum of molecular condensation or rarefaction, from which vibrations start. It is therefore of importance that this node may not be weighted or coerced. The experiments of Savart have proved the necessity of the cutting. The right foot of the bridge being nearly over the sound-post is itself in a nodal position, and the vibrations passing through it have been proved by the ingenious experiments of Dr. Huggins, at least in part, to be transmitted to the back. Were the violin a *pizzicato* instrument like the guitar or mandoline, no sound-post would be required, but as it is a *sostenuto* one, the continued incitement from the bow has to be carried on between the belly and back, and the sound-post does this, from which office the French and Italians call the sound-post the soul, and the Germans the voice of the instrument. It is a little round stick of spruce, a quarter of an inch in diameter, and is adjusted to firmly touch at about one-sixteenth to three-sixteenths of an inch behind the right foot of the bridge. It does not absolutely support the belly, because it might then arrest vibration, but it is practically made to fit. A

violin should be strong enough in itself to bear the strain of tension. As the sound-post has to be introduced through the right-hand hole, only a skilled hand, with experience to determine its exact size and position, can fit it. The bass bar is the other great tone regulator of the violin; it governs the elasticity of the belly, and increases it by the formation of a greater number of nodes or centres of no vibration, thus affecting both quality and carrying power. It is also of spruce, and is about $10\frac{1}{2}$ inches long and two-sixteenths in diameter, and should extend along the belly to which it is glued on the under side, in an oblique direction, but the deviation inwards very slight. The glued-edge has to follow the longitudinal vaulting of the belly. Its depth is about three-eighths of an inch where it is deepest. If too long or too large it will make the tone dull. The original bars of the old Italian makers are found to be too weak for the increased tension of the present day, and this is due to the thicker strings, the higher pitch, the higher bridge, and longer neck. The pitch usual in the time of Stradivari and Guarneri was at least a diatonic semitone lower than the present English Philharmonic or Kneller Hall pitch; that is to say a quarter of a tone lower than the Paris Diapason Normal. But in the 17th century the chamber or secular music pitch, from indications in the vocal music of the time, and, as we learn from Praetorius, who published his book in 1618, was about a tone and a half sharper than the very low pitch which followed it. So that the pitch Stradivari constructed his instruments for, differed from that which was incumbent upon the Amatis, and probably upon himself in his early days. When we consider such important changes as the altered pitch and the ageing of the wood, combined with the difference of the bow and style of playing, it becomes impossible to recall the impression made by the tone of the Cremona violins, when new, upon contemporary ears.

The neck and head^{*} are cut from a block of maple, and have to be set with due reference to the strain of the strings, which are attached to the pegs in the head. The necks of the old Cremona violins have now, on account of the use players make of the shifts, to be somewhat longer, and new ones are accordingly made and fitted to the head. The various fittings, such as the fingerboard, tail-piece, nut and tail-pin, are generally of ebony, but other woods have been used. Although ebony answers very well for the pegs, rosewood is

often preferred to it, but really boxwood is the best. A very important fitting is the finger-board, the measurement of which is given as $10\frac{3}{8}$ inches length, and breadth of $1\frac{3}{8}$ inch at the bridge to $\frac{5}{8}$ inch at the nut. It is rounded to agree with the shape of the bridge; the distance at the lower end between the strings and fingerboard decreasing from the fourth to the first string. It is three-sixteenths from the fourth string and one-eighth from the first. Stradivari, for a violin of 14 inches, placed his bridge from $7\frac{1}{2}$ to $7\frac{5}{8}$ inches from the top of the body. Seven inches five-eighths is the average measurement. The grain of the fingerboard runs parallel with the strings, but the nut which surmounts it, over which the strings have to pass clear of the fingerboard, is cut across the grain.

There is no constructive difference but that of dimensions between the three sizes of the members of the violin family, the violin proper, the tenor or viola, and the bass or violoncello. In the violin quartet the second place is taken by the violin proper, but the difference heard is considerable, owing to the second instrument being played in a lower part of the accordence. The instrument which takes the third place is the viola or tenor, which varies more in size than any other fiddle of the quartet. The size which is found to suit the convenience of the average player, and give the proper quality of tone, is from 16 to $16\frac{1}{2}$ inches. It is a fifth lower in the accordence, the open notes of the strings being C and G below middle C, and D and A above it. For the convenience of manipulation the size of this instrument is restricted, and it is consequently too short for the weight of stringing, an imperfection that causes the peculiar quality of the viola tone. The two lowest strings are overspun. There is reason to believe that a large viola or tenor was the first four-stringed fiddle made, and that the violin was a diminutive of it. There has been an attempt recently made to revive the use of the large-sized tenors, such as were made by Gasparo da Salo, the Amatis and other Italian makers, but perhaps owing to the large grasp required, the viola alta, as it has recently been called, has not been generally accepted, nor does it appear it will be.

The violoncello is the bass violin. Comparing measurements made by M. Vidal of admittedly fine instruments, the violoncello body is rather more than twice the length of the violin—2 feet $5\frac{1}{2}$ inches against 14 inches, and the breadth at the widest part, the lower bouts, follows the same proportion, viz., 1 foot

$5\frac{1}{2}$ inches nearly, against $8\frac{1}{4}$ inches. The standard length of body is, in fact, 2 feet 6 inches. It is one octave lower in pitch than the viola; the accordence is C below, and G, D, and A in the bass clef. The wider fingerboard renders a different fingering necessary, the aid of the thumb being brought in for the higher positions. The harmonics, which are of very full sound, and the *pizzicato*, which is very effective, are much admired. But far above these excellencies, the tone of the A string is before all in instrumental music for passionate expression. While the viola was in use as early, and perhaps earlier than the violin, the violoncello came later. It existed, however, in Italy and in Holland, in the early part of the 17th century. Its first use was with the other bass instruments in the Basso Continuo, then of recent introduction, and an invention powerfully influencing the progress of musical composition, but the difficulties of execution prevented anything like solo employment for a long while, or any competition with the favourite bass viol, the Viola da Gamba. The violoncello was for a long while of varying dimensions; Stradivari, in his fine period, determined the existing model.

In the modern orchestra, the double bass, the Italian violone or big viol, goes with the violoncello, but an octave lower. By its musical position, it might form one of the violin family, but it does not altogether as an instrument, having considerable likeness to the viols; the sloping shoulders are, however, necessary to the performer.

Gaspar da Salo, who is accredited with the invention of the violin, made double basses, and so also did Maggini; Messrs. Hill and Sons have one by this maker in their possession. The accordence of the double bass is, in England and Italy, three-stringed—A D below and G first space in the bass clef. Elsewhere it is four-stringed—E, A, D, G—and this accordence is rendered a necessity by modern composers; yet, the three-stringed viol tuning being the original, as well as on account of the greater sonorousness, favours its retention by double bass players. In the Crystal Palace band the three and four-stringed basses are equally divided.

I have not, so far, insisted upon the beauty of form and delicacy of curve a fine violin presents, nor its exquisite colour; these are not really included in my scheme, but yet have too great an importance to be entirely passed by. At first we wonder if they can affect the beauty of the tone! Certainly a fineness of work that

seems almost intuitive, so difficult has it been to imitate; and the lovely varnishing, now regarded as a lost art, must contribute to it. If the work is not carried to the utmost fineness and exactness, in any and every detail, the result suffers. The late Mr. Charles Reade, in a communication some years ago to the *Pall Mall Gazette*, has given his opinion upon the question of varnish thus:—"It is not an amber or a spirit varnish alone, but an oil varnish which contains a transparent gum, several times repeated until the pores of the wood were all filled up. Then several applications of a spirit varnish holding a colouring matter in solution, gave the exquisite result." He continues, "the beauty, therefore, of varnish lies in the fact that it is a pure, glossy oil-varnish, which serves as a foil to a divine, unadulterated gum, which is left as a pure film on it by the evaporation of the spirit in which it was dissolved. The first is a colourless oil varnish which sinks into and shows up the figure of the wood; the second is a heterogeneous spirit varnish, which serves to give the glory of colour, with its light and shade, which is the great and transcendent beauty of a Cremona violin." This passage, and more, of Mr. Reade's letter will be found in Mr. Heron Allen's "Violin Making as it was and is," pp. 171-2 (London, 1884) a work to which I am much indebted, as well as to Mr. George Hart's "The Violin: Famous Makers and their Imitators" (second edition, London, 1884), and Mr. E. J. Payne's articles in Grove's "Dictionary of Music and Musicians" upon the violin and its congeners.

Mr. Heron Allen accepts Mr. Reade's theory as a sufficient one, but Mr. Payne, so far as I can gather from his writings, separates the discovery and use of spirit varnish from the older oil varnish. Mr. Hart shall sit in judgment, so far as it can be given. He says "that the varnish does influence the tone there is strong proof, and to make this plain to the reader should not be difficult. The finest varnishes are those of oil, and they require the utmost skill and patience in their use. They dry slowly, and may be described as of a soft and yielding nature. This common varnish is known as spirit varnish; it is easily used, and dries rapidly, in consideration of which qualities it is generally adopted in these days of high pressure. It may be described as precisely the reverse of oil varnish: it is hard and unyielding. Now, a violin varnished with fine oil varnish, like all good things, takes time to mature, and will not bear forcing in any way.

At first, the instrument is somewhat muffled, as the pores of the wood have become impregnated with oil. This makes the instrument heavy, both in weight and sound; but, as time rolls on, the oil dries, leaving the wood mellowed, and wrapped in an elastic covering, which yields to the tone of the instrument, and imparts to it much of its own softness. We will now turn to spirit varnish. When this is used, a diametrically opposite effect is produced. The violin is, as it were, wrapped in a glass, through which the sound passes, imbued with the characteristics of the varnish."

Mr. Hart's description is not exactly final: he prefers to leave each one to form his own opinion. I may be allowed to repeat his judgment in other words, viz., that the saturation of the wood by oil quenches the reinforced continuance of the discordant higher partials of the strings, leaving the less evanescent lower partials to make their satisfying effect upon the ear; while glazing the instrument with a spirit varnish has no such beneficial effect. Mr. Hart ventures to suggest the possibility of the particular gums used having ceased to be obtainable. There are still pure oil varnishes to be obtained; but the question of time and expense seems to preclude their use.

We will now turn to the capabilities and intrinsic value, musically, of the violin family.

As a colour is, in itself, a beautiful thing, or is one we are indifferent to, or may even avoid, so it is with musical sounds; and I should be disposed to put back the dawning of music to some such pleasure in hearing a musical sounding note, rather than the chaining together of distinct musical sounds in scales, modes, melodic types, or real melodies. These came, possibly, later, although before the dawn of history: simultaneous notes, or harmony, however simple, is comparatively of yesterday. It is the charm of tone-quality, or its pleasing individuality, apart from rhythm, that is the first element of lyric beauty. Now, it is more a penetrating individuality, than a persuasive charm that characterises the tone-quality of the very finest violin. By shifting the hand along the finger-board, an upward extension of compass carries with it an enormous increase of dramatic power; and the violin has the remarkable attribute of an increase in effect nearly commensurate with the increase of the number of violins employed, so that with its congeners, the viola and violoncellos, the violin family

becomes the acme as well as the basis of the orchestra. The middle register of the viola has a fine quality of plaintive, almost complaining expression, but the song of a violoncello is inexpressively lovely, and of several violoncellos combined, is far and away the most touching *cantabile* in the symphony. With, however, all this brilliancy and power, there is a gentler and more intimately sympathetic tone-quality latent in a chest of viols—at least, for domestic use. These instruments are the elder cousins of the violins, and had the start by a century or more; then for a century there was a rivalry, in which the violin family became at last the victors. In the struggle for existence the most powerful wins; and so it has been between the violins and viols. The truth and fitness of these remarks will be proved by a performance of 17th and 18th century string music which Mr. Dolmetsch and his pupils will play at the close of this lecture with viols and then with violins. Leaving out the double bass as possibly belonging to both families, the viols are, like the violins, divided into three sizes—the treble, the tenor, and bass viols—the last being the once favourite viola da gamba, which appears to have a chance of being resuscitated like certain other old and now obsolete instruments having special tone-qualities: indeed, there is a professor of the viola da gamba in a Musical Directory for 1891. The soft and gentle character of the viol tone was particularly fit to blend with the lutes and other plucked stringed instruments that were in contemporary use. The viol differs from the violin in having nearly flat tables, the back one sloped off from the neck, and high ribs; the sound-holes being at first *c c*'s instead of *f f*'s, segments of the old single circular sound-hole which is still retained in the guitar and mandoline, as it was in the lute and theorbo. The *f* has been designed from the crescent *c* by reversing the lower member. Another form of sound-hole, known as the "flaming sword," a double bending of the line which afterwards formed the *f*, was always maintained in the viola d'amore, while the viola da gamba kept to the reversed *c*. Mr. Payne credits Stradivari with the introduction of the violin sound-hole into the smaller viols in which other Italian makers followed. Mr. Hart places this change much earlier. The violin never had frets to mark off the stops; the viols it may be said always. It must be remembered the viols with their five, six, or seven strings, tuned in fourths, with the ex-

ception of one major third to preserve the diatonic relation, were like the lutes, more available for harmony than the violins, which always tended to melody, or one part only, their origin being possibly in the crowd and rebec, instruments of the people and of popular tunes. All the strings were gut, and the frets were never more than seven. We have record for the accordance for six-stringed viols from Ganassi del Fontego ("Regola Rubertina," Venice, 1542) to John Playford ("Introduction to the Skill of Music," London, 1697), lasting the same for more than 150 years. For the treble viol D, G, in the bass clef, middle C, E, A, and D, in the treble clef; for the mean, or tenor viol, C, F, A, in the bass clef, D above middle C, and G in the treble clef; for the bass viol, D below, and G, C, E, A, in the bass clef, with D above middle C.

It would seem as if the double bass had been tuned a fourth lower than the bass viol, and was afterwards lightened of the three higher and useless strings. This is Mr. Payne's plausible suggestion. There were of course variations in the accordance according to the fancy of the player, to whom, in this respect, some license was given. The tenor viol was sometimes made in two sizes, contralto and tenor, and in Italian it bore the names of viola "da spalla" or "da braccio," the shoulder or arm viol, which explain themselves. The bass viol was "viola da gamba," the leg viol; it was made in three sizes, the largest for concert or "continuo" playing—one of the instruments that played the thorough bass; the medium size, "the division viol," for solo performance of variations, then called divisions; and the smallest the lyra viol, played from the special tablature or lute notation, and, therefore, presumably one of the lute concert. In the last century the treble and tenor viols were reduced in the number of strings, until at last they approximated to, and were ultimately beaten off the field, by the treble and tenor violins.

One variety, however, of the tenor viol has, like the bass viol, a chance of being restored to favour. I speak of the viola d'amore, a tenor viol with sympathetic strings of fine steel wire stretched beneath the gut strings, and vibrating, not from contact with the bow, but by influence. The effect of this has the tendency to affect the imagination like a piano being set free to vibrate by the pedal. The accordance was that of the old tenor viol; and that has been resumed by Mr. Dolmetsch, who finds it more useful than the common chord, or

"harp way" tuning, as they used to call it, adopted by the French violinist, Urhan, who induced Meyerbeer to write an *obbligato* part for this instrument, to accompany Raoul in his first song in the "Huguenots." It was then this interesting instrument was revived; but it is chiefly of late years it has come again into notice. The carved head of this viol has, usually, bandaged eyes: it may be to represent love. The violone d'amore was called the baryton, or viola da bordone, the significance of bordone being drone, possibly because there were, as well as the sympathetic strings, some extra open strings the player could touch with his thumb. An early form of baryton was known as the viola bastarda.

The latest phase of the violin has been its commercial and mechanical manufacture, which, against much that is to be regretted, has had the merit of placing the instrument within nearly everyone's reach, so that there is no reason there should not be a fiddle in every house; and, if it were more generally taught to the young, in addition to singing, England might have the advantage of becoming a much more musical nation than it is. Mittenwald, in Bavaria, Mirecourt, in Lorraine, and Markneukirchen, in Saxony, are the chief seats of this wholesale fiddle manufacture. Mirecourt produces, for quality, the best of these cheap instruments. The models are those of Cremona with all; and Mr. Payne asserts, with reference to fiddles sold for a few shillings at Mirecourt, that it is certain that one of them, carefully set up, can be made to discourse very tolerable music. Of course, better prices always command better results. Excellent violins are still being made in London and Paris. I need not specify our well-known London makers, except to add to authorities I am under obligations to in preparing these lectures, Messrs. Hill and Sons, of New Bond-street, a firm making great efforts to restore to England the good repute it formerly enjoyed for violin making. Messrs. Hill have very kindly let me have a selection of parts of a violin, to serve as examples for what I have endeavoured to explain.

To show the difference between viols and violins, Mr. Dolmetsch and his pupils will play two pieces; for viols, a courante, air and saraband, from the "Consort of four parts," by Matthew Locke; and for violins, an adagio and minuet, from a quartet by Haydn. The viols are, a five-string treble one, by Guersan, Paris; a six-string treble, by Feyzeau, Bor-

deaux; a five-string tenor, probably by Simpson, London; and a six-string viol da gamba, which will be played by Miss Hélène Dolmetsch, by Barak Norman, London, of the year 1702. The violins are by Guadagnini and Cuypers; the tenor, Betts; and the 'cello probably old German, although labelled Amati. Mr. Dolmetsch has also brought with him a seven-string viola d'amore, by Johann Hädl, Regensburg, 1720; and a seven-string viola da gamba, also with sympathetic strings, by Carlo Bergonzi, Cremona, 1720.

As it is my intention to complete my review of stringed instruments this evening, I will now turn to the harp and guitar; the only instruments remaining in use that are plucked with the fingers; the last in fact of a class of instrument that prevailed during the 15th, 16th, and 17th centuries. The only harp now used is the double action harp of Sebastian Erard, of which by an ingenious pedal mechanism the pitch can be raised a semitone, that is from C flat, in which the instrument is set, to C natural, and again, by a second semitone to C sharp. This harp, as an instrument of fixed tones, more nearly approaches our theoretical or written music by separate flats, naturals, and sharps, than any other. Any passages may be repeated in any key with the same fingering, but it can hardly play the chromatic scale, or certain arpeggios that are of chromatic formation. The strength of the instrument lies in its sympathetic tone-quality, and in its great power of full-sounding arpeggios. The harmonics obtained by touching the middle of the string with the thumb, are very beautiful. The mediæval harp had no transposing mechanism. The first step towards it was screwing hooks into the neck or comb, which could be bent back upon a string to sharpen it. About the year 1720, Hochbrucker, a Bavarian, invented the first pedal mechanism. The Cousineaus, who were Frenchmen, improved upon it in 1782, doubled the pedals, and produced the first double-action harp. They changed the open tuning from E flat to C flat. The merit of Erard's invention is the admirable ingenuity shown by him in contriving a system of disks to act upon the strings successively with a partial revolution, the first movement of the pedal serving to shorten the strings to produce the first rise of a half tone, and the second movement to attain the whole tone. The position of the upper disk, which is the second to move but the first to act upon the strings, not being changed when the lower

disk completes its movement of revolution by stopping the next half tone. For this Erard needed seven pedals only, the same as in the older single-action harp. It is not necessary to keep the foot pressed down upon a pedal, as it may be fixed in a notch. Besides this action, Erard transformed the neck, which had been cut from a solid piece of wood, into a glueing up of several pieces, which ensured the grain running as he desired; and the sound-body, bearing the sound-board, which had been joined up of seven or nine pieces after the fashion of a lute sound-body, he made with fewer joinings and with four transverse bars. Recent composers for the orchestra have made valuable use of the harp, which more than compensates, from a musical point of view, for the neglect of it by amateurs. The guitar and the now obsolete lute are certainly of Eastern origin, and the guitar carries some part of its history with it, as the incured sides point to a time when the instrument it is derived from was indifferently sounded by touch or bowing. No doubt a raised bridge determined this guitar-fiddle into an ancestor of the tenor viol. The guitar bridge proper is combined with the string-holder, upon which a sharp edge allows the string a definite vibration, which is carried through to the belly. As there is no sustained vibration, there is no sound-post. The circular sound-hole is mediæval. The back and ribs are usually made of maple, ash, service, or cherry-tree, sometimes veneered and inlaid with rosewood and other fancy woods, and even with ivory. Modern guitars have six strings, three of gut and three of silk, spun over with silver wire. The accordance is E below, and A, D, and G in the bass clef, B next to, and E above middle C. The strings were formerly in pairs. Metal screws have replaced the wooden pegs of the true Spanish instrument. The spun strings are twanged with the thumb, the gut strings with the first, second, and third fingers, the little finger resting as a support upon the belly, which, in real Spanish instruments, has frequently a guard of tortoiseshell or other hard substance inserted. The finger-board is marked with frets. The use of the guitar is chiefly for accompaniment, either of the voice or of the shortened guitar, and the other truly Spanish instrument, the *bandurria*. This is also flat-backed, but is played with a plectrum, like a mandoline, and with similar *sostinente* effect, got by rapid repetition of a note on the melody strings. The *bandurria* has three notes of gut, and three notes of spun

strings, in pairs, with the accordance G, C, F, G, in the bass clef, and E, A in the treble. Spanish *Estudiantina* in London, in 1879, and again in 1889, were bands composed of several *bandurrias* and a few guitars of various sizes, having, as well as the ordinary *guitarra*, the *octavilla*, or octave guitar, the *laude-citara*, or wire-strung guitar, and the *guitarra-baja*, a large bass one. Their national dances so played are very interesting and pleasing, and frequently of Oriental character.

The Portuguese *machêta* is an octave guitar, strung with four strings, D below, and G, B, D, or E in the treble clef. It is a favourite instrument in Madeira. Bands of these little instruments accompanied by a guitar are to be met with there.

The wire-strung English guitar is one of the cithers once very common in France and Italy, as well as in this country. It is smaller than the guitar, and has an oval body with a flat back. The wire strings were always in pairs; but, when spun strings were adopted for the lower notes, they were single. The tunings were various; but at last the "harp way"—C, E, G bass clef, and C, E, G, an octave higher—suited the simple accompaniment required, the thumbnail, and probably that of the first-finger being used for plectra.

Concerning other and older accordances, I must content myself by referring to Carl Engel's "Musical Instruments in South Kensington Museum" (London: 1874), or to Lavoix's "Histoire de l'Instrumentation" (Paris: 1878). The now well-known South German *zither* is a rather hybrid instrument, being apparently derived from the horizontal psaltery or dulcimer, played with a plectrum, and the true *zither*, of which it has the finger-board and a ring plectrum, while the bass strings are touched by the fingers. Thousands of these instruments are made annually in Germany. The *streich*, or bow *zither*, combines the viol instead of the cither. It is obsolete, but in the *viola-zither*, and *philomèle* has been improved and re-introduced by Herr Curt Schulz.

The last remaining descendant of the lute family is the mandoline, a pleasing stringed instrument that has again come into favour. It is, in its present form, a later development of the soprano of the mandola or mandora, as the *pandurina* was the soprano of the lute. The *mandora* and the lute are pear-shaped instruments without the ribs which a flat-backed instrument requires. *Mandora* and lute are differentiated by the stringing which on the *mandora* is wire

or wire and gut, and on the lute gut only; the mandora strings on account of the wire being struck with a plectrum; the lute strings twanged by the fingers. These instruments, in the 15th and 16th centuries, were made in families, like viols and various wind instruments. The present mandoline is the Neapolitan, an 18th century instrument, tuned like a violin, in fifths, but with fretted finger-board. The accordance enables anyone familiar with the violin to stop the the mandoline easily; What remains difficult is the management of the plectrum and those ethereal *sostinente* effects got from the melody strings by rapidly repeating a note. The predecessor of the Neapolitan mandoline was the Milanese with five or six pairs of strings tuned in the viol and lute accordance of fourths and a major third. As to the lute itself, which is now rarely to be met with as an instrument even in museums, no *pizzicato* stringed instrument could surpass it in charm of dignified full-sounding tone. The tenor lute was the favourite stringed instrument of the 16th century. For a long while it had eleven strings, tuned G, C, F, A, in the bass clef, and D above middle C, G in the treble clef; the highest, the chanterelle or melody string being single. With a low pitch this accordance was placed a note higher. Towards the end of that century, the requirements of the then newly invented monody and thorough bass accompaniment led to open strings being added to the bass, called diapasons, which descended in scale as low as C below the bass clef, and in bass lutes A or G. There was subsequently what I may call a D minor tuning, which became the most used; I will quote it from Baron (Nuremberg, A.D. 1727)—diapasons C, D, E, F, below, and G in the bass clef; accordance A, D, F, A, in the bass clef, D above middle C, and F in the treble clef; but he wisely remarks in his book, "the tuning upon any instrument which allows the artist most scope, freedom, and variety, with most ease and familiarity, to express his conceptions most fully and completely, without limitation or restraints throughout all the keys, must be accounted the best." One characteristic of the lute was the neck bent back at an obtuse angle, derived from its Arab ancestor, with the tuning pegs inserted sideways in the head. This differed from the guitar head, the angle of which was much less pronounced and the pegs pierced the head from the back. The oldest cither head was upon a scooped out semi-circular neck like the primitive rebec. The object of

the sharp angle was to give bearing upon the nut or chief fret (*capo tasto*); there were at last nine frets of gut bound round the neck and fingerboard besides, adjusted in semi-tones. But the increase of tension due to the very high pitch which obtained in the early years of the 17th century, was a great strain upon an instrument with a very thin spruce, cedar, or cypress belly, no ribs or blocks of any kind, and a body built up of similar resounding wood, in slender staves 6, 9, 12 or more in number. Still the bass was not powerful enough for the "continuo," and a great step to assist it in this direction was made when about A.D. 1600 the theorbo, or double-necked bass lute, was invented. Now the diapasons or non-fretted strings were no longer double strings, but single ones of greater thickness, and this led to the substitution of single strings throughout. Some possessors of large lutes with many double diapasons had their instruments altered into theorbos, theorboed lutes they were called, and in the correspondence of Constantine Huygens, a delightful work published at the Hague, and edited by Jonkbløet and Land, the musical part entirely by the latter, we find Huygens seeking such a large lute for transformation. The Paduan was the true theorbo, an instrument about five feet high; the arch-lute of modern French and Italian writers which the German Prætorius and Baron call chitarrone, of six feet high or thereabouts, was also known as the Roman theorbo. I believe the true Italian arch-lute was simply the double gut strung theorbo, and the true Italian chitarrone, the wire-strung theorbo. The interest in these tender instruments has passed away perhaps not to be revived. They bear no relation to the stress of our modern life, but if we turn to our older music, our older poetry and literature, we seem to come nearer to them, and Shakespeare's Dowland is not a mere name.

Miscellaneous.

THE AGRICULTURAL PRODUCTS OF MADAGASCAR.

M. d'Anthouard, Chancellor of the French Residency at Antananarivo, has recently made to the French Government an interesting report upon the economic condition of Madagascar. In that portion of the report which is devoted to the consideration

of the agricultural development of the island, it is stated that the chief agricultural products are sugar, coffee, cocoa, vanilla, cloves, rice, potatoes, tamarinds, indigo, wine, oranges, and lemons. Sugar cultivation was first commenced in 1842; and two factories were erected at Manangary. Good results were obtained in the first two years; but, during the third year, riots took place among the workmen, and the plantations were destroyed. In 1878, three new factories were established in the neighbourhood of Tamatave; and, in 1883, on the outbreak of hostilities between France and Madagascar, they were in full working. At the present time, the number of plantations round Tamatave has greatly increased; and also in the south, towards Mahanoro and Vatomandry. The expenses of cultivating are greater near Tamatave, by reason of the high price of land and the scarcity of labour, than in the south, towards Vatomandry and Manangary, where labour and land are cheap. Leases are usually granted for 25 years, renewable at option. They may even be granted for a period of 99 years. Coffee trees grow well in Madagascar; and it is stated to be by no means an uncommon thing to see plantations that are 45 years old, and even more, which have never ceased to yield good results. European travellers, it is said, are frequently struck by the healthy appearance and the quantity of berries in most of the plantations made round the houses or in the villages inhabited by the natives, even when these plantations appear to be abandoned and left to take care of themselves. A large plantation has recently been established in Imerina by a French company; it extends over an area of 325 hectares (hectare = 2.47 acres). Great results are expected from the development of the coffee industry in Madagascar, as the difference between the cost price and the price it realises in European markets allows of a considerable outlay on its cultivation and then leaves a large margin of profit. The cocoa tree was introduced into Madagascar by means of seeds brought from the Mauritius and Reunion, in which places it has been for a long time a source of considerable revenue. The tree commences to bear at the end of three years, but it is only in full bearing at the end of the fifth year, and it so remains for thirty years. The cost of cultivation is less than that of coffee. The cocoa tree is chiefly cultivated in the eastern portion of the island, and it is only of recent years that the industry has assumed any importance. In 1883 there were not less than five or six thousand trees round the coast, and these were abandoned when the war broke out. After the war, it was found that, notwithstanding the want of care and attention, the young cocoa plantations were still flourishing, and this phenomenon encouraged the planters to pay greater attention to the development of this cultivation. This development dates from the year 1888. Like cocoa, vanilla is one of the agricultural products which has a great future before it in Madagascar, and its cultivation is largely

engaged in in Valomandry, Mahanoro, and Mahela. Vanilla plants commence to yield after the third year, and in the fourth they are in full bearing. The cultivation of rice, which is well developed in the interior of the island, is very much less so on the coasts, where the land is more fertile. While in the latter districts the inhabitants are content to sow the seed without any preparation of the ground but the burning of the trees and grass, the Hovas and the Betsileos, having a much poorer soil, take more pains to develop and perfect their system of cultivation. In some instances, for example, in the neighbourhood of Antananarivo, they have transformed immense tracts of marsh land into rice plantations. The plains of Betsimitatatra, towards the west of the capital, which are watered by the Ikopa, Andromba, and Sisaony rivers, now the centre of the rice production in Imerina, have been drained and cleared; irrigating canals have been pierced, and everything has been done to favour the production. Similar well cultivated plains are found in great number in the south of Imerina and in Betsileo. In the mountain districts the rice grounds are laid out in terraces on the slopes of the mountains and hills, and rice ground are frequently met with rising tier upon tier up to the very summit of the high mountains. The following is the method of cultivation employed by the Hovas and Betsileos. The rice is first of all sown, then, when it has attained a height of fifteen centimetres, it is plucked up and replanted. The preparation of the ground is an operation to which considerable attention is devoted; it is first of all heavily manured, and when the seed is sown and commences to shoot up, it is subjected alternately to the action of the sun and moisture. In the transplanting, the same system is followed as in other rice-growing countries, care being taken to choose a wet season of the year. The ground must, first of all, have been subjected to various treatments, which would have the effect of transforming it into a kind of mud. In many districts this is effected by trampling over the inundated lands, already softened, by driving herds of oxen over them. An improvement in the methods of cultivation practised by the natives of the coast, and of the means of transport would, it is said, give to this industry its old importance. As regards the future of rice cultivation in the interior, it would never rise beyond the needs of local consumption, as it would be impossible for a low-priced product such as this to bear the heavy expenses of transport by land. Its cultivation, however, would prove remunerative to farmers and others if they would establish factories for the distillation of the alcohol obtained from the rice. At the present time, in the interior of the island, a tenth part of the rice lands only are cultivated, and this suffices for the requirements of home consumption. Potatoes are largely cultivated in the districts round Ankaratra, and considerable quantities are placed upon the neighbouring markets and at Antananarivo, principally for the consumption of the natives. Tamarinds

are common all over the west coast, where the plants form immense thickets. The Sakalaves distil spirit from the fruit. Peaches grow almost wild all over the island, and the same may be said of the indigo plant. As regards vines, there are different species in Madagascar. One variety was originally imported from Portugal; another variety appears to be indigenous to the soil. In Imerina attempts have been made in recent years to acclimatise vines, but some which were brought from Bordeaux have not succeeded. On the other hand, American vines have prospered, but the grapes are not of a superior kind, and the wine made from them is very poor. Orange and lemon trees are found all over the island, growing in a wild state on the coasts, and cultivated in the interior. As regards textiles, ramie, flax, cotton, and hemp are grown. Plantations of the former were made at Vatomandry, in 1882, which have since increased. The want, however, of decorticating machines has caused this cultivation to be abandoned. Hemp is cultivated in Imerina and Betsileo. Cotton was formerly an important cultivation in Madagascar. The natives gathered it, and themselves manufactured the tissues, which served them for clothing. Since the importation, however, of American and English cottons, the local industry has been almost killed. M. d'Anthouard says, that in view of the fact that cotton grows so easily and quickly in Madagascar, more particularly in the territories bordering on the west coast, where it may be found almost in a wild state, it seems extraordinary that no one, up to the present, has thought of making cotton plantations, either for the export of the raw material, for working it up on the spot, and selling the yarn to the natives, or even for making tissues which, seeing the heavy expenses of freight and transport which bear upon foreign products, would compete very favourably with similar American goods.

RESOURCES AND INDUSTRIES OF PARAGUAY.

A report upon the American Republics recently issued by the United States Department of State shows that in Paraguay there were, in 1887, 730,000 sheep, 32,000 horses, 62,000 goats, and other domestic animals. Besides yerba, the principal product, tobacco, corn, rice, wheat, manioc, cotton, barley, and sugar are grown. Only about 158,100 acres were under cultivation in 1887. There is no country in the world with greater variety of woods of all kinds applicable to industry. Amongst those used for tanning purposes may be mentioned the algaroba and quebraco; for dyeing, algarobilla, indigo, annotto (used for colouring butter, cheese, &c.), and many others. Resins, dragon's blood, copal, *lignum vitæ*, &c.; balsams in many varieties, india-rubber, &c., abound. Amongst the indigenous textile plants for clothing may be mentioned cotton,

which gives a plentiful crop, ramie, jute, palm, pineapple, mapajo, and other fibrous plants, the latter producing more luxuriantly than cotton, and used by the natives in the manufacture of clothing. Of medicinal drugs there are copaiba, rhubarb, sassafras, jalap, sarsaparilla, *nux vomica*, and licorice. The fauna comprises monkeys, tapir, peccary, armadillo, carpincho, deer, tiger cat, nutria, chinchilla, and many others. Birds in endless variety are to be found. The rivers swarm with fish of good quality, and carry upon their surface many varieties of sea-fowl, wild geese, and ducks. As regards the mineral production, quartz, agate, onyx, granite, basalt, saltpetre, white clay, marble, carbonates, gypsum, kaolin, magnesium, iron, copper, quicksilver, &c., exist in more or less quantities, and are ready at hand for use in industry, arts, and sciences. Primitive stills for distilling the juice of the sugar-cane into rum may be found in almost every village of Paraguay. There are sugar-mills, flour-mills, soap factories, breweries, a few steam saw-mills, several tanneries, numerous brick factories, and two factories for making vermicelli, which is used in one of the national dishes known as *sopa de fideos*, a mixture of boiled vermicelli, tomatoes, and eggs, making a soup which is largely consumed in Paraguay. The potteries of Ita produce some very curious articles. Towels and other articles are made at Aragua of native materials. The women throughout the country make very intricate puzzle rings of gold, and handkerchiefs and embroidery of lace, which are famous in Paraguay. All these are remarkable for the delicacy of work and the originality of design.

Obituary.

Mr. WILLOUGHBY SMITH died at Eastbourne on July 17th last, at the age of 63. In 1848 he entered the service of the Gutta Percha Company, and superintended the manufacture and laying of the first submarine cable. This company afterwards was merged in the Telegraph Construction and Maintenance Company, and Mr. Smith remained as chief electrician and manager of the gutta percha works until his retirement through failing health in 1887. In 1866 he was electrician-in-charge on board the *Great Eastern* during the laying of the first successful Atlantic cable, and the recovery and completion of the cable that had been lost the year before. Mr. Smith was president of the Institution of Electrical Engineers in 1883. Amongst the most interesting of his discoveries was that of the effect of light on the electrical condition of selenium. As a rule his researches were more practical in their direction, and his inventions were very numerous and important. He was a member of the Society of Arts from 1870.

Journal of the Society of Arts.

No. 2,020. VOL. XXXIX.

FRIDAY, AUGUST 7, 1891.]

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

The Secretary, Sir Henry Trueman Wood, has been instructed by the Council to visit Chicago at once; and he will leave England for this purpose in the first week of September. Exhibitors who are likely to require special arrangements made for them—such, for instance, as relate to permission to erect special buildings in the grounds—would do well to communicate with him before his departure.

UNITED STATES LABOUR LAW.

The following circular has been issued containing the opinion of the United States Attorney-General on the subject of the Contract Labour Law of the United States:—

“Department of State,
“Washington, July 16, 1891.

“To the Diplomatic and Consular Officers of
the United States.

“GENTLEMEN,—Some doubt having arisen among certain foreign Governments as to the effect of the Contract Labour Laws of the United States, as applied to the Chicago Exposition of 1893, the Secretary of State has requested an official opinion from the Attorney-General upon the subject.

“The cases presented concerned skilled experts, who may come from foreign countries to aid foreign exhibitors in setting up and operating machinery to be brought to the United States, and exhibited at the World's Columbian Exposition; also clerks, stall-keepers, and other persons whose services may be required by foreign exhibitors at that Exposition.

“After fully discussing the legislation upon the

subject, the Attorney-General has tendered an opinion that skilled *employés* of foreign exhibitors at the Chicago Exposition, who come, in good faith, for the purpose of setting up and operating the machinery of such exhibitors, are outside of, and not subject to, the contract labour laws of the United States.

“The same opinion is expressed with reference to clerks, stall-keepers, and other persons coming to the United States for the sole purpose of aiding foreign exhibitors.

“This construction of the law expresses the natural and reasonable intent of the contract labour legislation of this Government as applicable to the approaching Chicago Exposition, and is in harmony with the spirit and purposes of the Act of Congress approved April 25, 1890, providing for the due and proper celebration of the four hundredth anniversary of the discovery of America by Christopher Columbus.

“You will, therefore, transmit copies of this circular to the Government to which you are accredited for its information.

“I am, gentlemen,

“Your obedient servant,

“WILLIAM F. WHARTON,
“Acting Secretary.”

Proceedings of the Society.

CANTOR LECTURES.

MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.

BY A. J. HIPKINS, F.S.A.

Lecture II. — Delivered February 2, 1891.

I will now invite your attention to the wind instruments which, in Handel's time, were chiefly used to double in unison the parts of stringed instruments. Their modern independent use dates from Haydn; it was extended and perfected by Mozart, Beethoven, and Weber; and the extraordinary changes and improvements which have been effected during the present century, have given wind instruments an importance that is hardly exceeded by that of the stringed, in the formation of the modern orchestra. The military band, as it now exists, is a creation of the present century.

The so-called wood wind-instruments are the flute, oboe, bassoon, and clarinet. It is as well to say at once that their particular qualities of tone do not absolutely depend upon the materials of which they are made. The

form is the most important factor in determining the distinction of tone-quality, so long as the sides of the tube are equally elastic, as has been submitted to proof by instruments made of various materials, including paper. I consider this has been sufficiently demonstrated by the independent experiments of Mr. Blaikley, of London, and Mr. Victor Mahillon, of Brussels. But we must still allow Mr. Richard Shepherd Rockstro's plea, clearly set forth in a recently-published treatise on the flute, that the nature and the substance of the tube by reciprocity of vibration, exercise some influence, although not so great as might have been expected, on the quality of the tone. But I consider this influence is already acknowledged in my reference to equality of elasticity in the sides of the tube.

The flute is an instrument of *embouchure*—that is to say, one in which a stream of air is driven from the player's lips against an edge of the blow-hole to produce the sound. The oboe and bassoon have double reeds, and the clarinet a single reed, made of a species of cane, as intermediate agents of sound-production. There are other flutes than that of *embouchure*—those with flageolet or whistle heads, which, having become obsolete, shall be reserved for later notice. There are no real tenor or bass flutes now, those in use being restricted to the upper part of the scale. The present flute dates from 1832, when Theobald Boehm, a Bavarian flute player, produced the instrument which is known by his name. He entirely remodelled the flute, being impelled to do so by suggestions from the performance of the English flautist, Charles Nicholson, who had increased the diameter of the lateral holes, and by some improvements that had been attempted in the flute by a Captain Gordon, of Charles the Tenth's Swiss Guard. Boehm has been sufficiently vindicated from having unfairly appropriated Gordon's ideas. The Boehm flute, since 1846, is a cylindrical tube for about three-fourths of its length from the lower end, after which it is continued in a curved conical prolongation to the cork stopper. The finger-holes are disposed in a geometrical division, and the mechanism and position of the keys are entirely different from what had been before. The full compass of the Boehm flute is chromatic, from middle C to C, two octaves above the treble clef C, a range of three octaves, which is common to all concert flutes, and is not peculiar to the Boehm model. Of course, this compass is partly produced by altering the pressure of

blowing. Columns of air enclosed in pipes vibrate like strings in sections, but, unlike strings, the vibrations progress in the direction of length, not across the direction of length. In the flute, all notes below D in the treble clef are produced by the normal pressure of wind—by an increasing pressure of overblowing the harmonics D, in the treble clef, and A and B above it—are successively attained. The fingerholes and keys, by shortening the tube, fill up the required intervals of the scale. There are higher harmonics still, but flautists generally prefer to do without them when they can get the note required by a lower harmonic. In Boehm's flute, his ingenious mechanism allows the production of the eleven chromatic semitones intermediate between the fundamental note of the flute and its first harmonic, by holes so disposed that, in opening them successively, they shorten the column of air in exact proportion. It is, therefore, ideally, an equal temperament instrument and not a D major one, as the conical flute was considered to be. Perhaps the most important thing Boehm did for the flute was to enunciate the principle that, to insure purity of tone and correct intonation, the holes must be put in their correct theoretical positions; and at least the hole below the one giving the sound must be open, to ensure perfect venting. Boehm's flute, however, has not remained as he left it. Improvements, applied by Clinton, Pratten, and Carte, have introduced certain modifications in the fingering, while retaining the best features of Boehm's system. But, it seems to me, that the reedy quality obtained from the adoption of the cylindrical bore which now prevails does away with the sweet and characteristic tone-quality of the old conical German flute, and gives us in its place one that is not sufficiently distinct from that of the clarinet.

The flute is the most facile of all orchestral wind instruments; and the device of double-tonguing, the quick repetition of notes by taking a staccato T-stop in blowing, is well known. The flute generally goes with the violins in the orchestra, or sustains long notes with the other wood wind instruments, or is used in those conversational passages with other instruments that lend such charm to orchestral music. The lower notes are not powerful. Mr. Henry Carte has, however, designed an alto flute in A, descending to violin G, with excellent results. There is a flute which transposes a minor third higher than the ordinary flute; but it is not much used in the orchestra,

although used in the army, as is also a flute one semitone higher than the concert flute. The piccolo, or octave flute, is more employed in the orchestra, and may double the melody in the highest octave, or accentuate brilliant points of effect in the score. It is very shrill and exciting in the overblown notes, and without great care may give a vulgar character to the music, and for this reason Sir Arthur Sullivan has replaced it in the score of "Ivanhoe" by a high G flute. The piccolo is exactly an octave higher than the flute, excepting the two lowest notes of which it is deficient. The old cylindrical ear-piercing fife is an obsolete instrument, being superseded by a small army flute, still, however, called a fife, used with the side drum in the drum and fife band.

The transverse or German flute, introduced into the orchestra by Lulli, came into general use in the time of Handel; before that the recorders, or flute douces, the flute à bec with beak or whistle-head, were preferred. These instruments were used in a family, usually of eight members, viz., as many sizes from treble to bass; or in three, treble, alto or tenor, and bass. A fine original set of those now rare instruments, eight in number, was shown in 1890 in the Music Gallery of the Royal Military Exhibition at Chelsea; a loan collection admirably arranged by Captain C. R. Day. They were obtained from Hesse Darmstadt, and had their outer case to preserve them exactly like the recorder case represented in the painting by Holbein of the ambassadors, or rather the scholars, recently acquired for the National Gallery. The flageolet was the latest form of the treble, beak, or whistle-head flute. The whistle-head is furnished with a cavity containing air, which shaped by a narrow groove, strikes against the sharp edge and excites vibration in the conical pipe, on the same principle that an organ pipe is made to sound, or of the action of the player's mouth and lips upon the blowhole of the flute. As it will interest the audience to hear the tone of Shakespeare's recorder, Mr. Henry Carte will play an air upon one.

The oboe takes the next place in the wood wind band. The principle of sound excitement, that of the double reed, originating in the flattening of the end of an oat or wheat straw, is of great antiquity, but it could only be applied by insertion in tubes of very narrow diameter, so that the column of air should not be wider than the tongue straw or reed acting upon it. The little reed bound round

and contracted below the vibrating ends in this primitive form permitted the adjustment of the lower open end in the tube, it might be another longer reed or pipe which enclosed the air column; and thus a conical pipe that gradually narrows to the diameter of the tongue reed must have been early discovered, and was the original type of the pastoral and beautiful oboe of the modern orchestra.

Like the flute, the oboe has only the soprano register, extending from B flat or natural below middle C, to F above the treble clef, two octaves and a fifth, which a little exceeds the flute downwards. The foundation of the scale is D major, the same as the flute was before Boehm altered it. Triebert, a skilful Parisian maker, tried to adapt Boehm's reform of the flute to the oboe, but so far as the geometrical division of the scale was concerned, he failed, because it altered the characteristic tone-quality of the instrument, so desirable for the balance of orchestral colouration. But the fingering has been modified with considerable success, although it is true by a much greater complication of means than the more simple contrivances that preceded it, which are still preferred by the players. The oboe reed has been much altered since the earlier years of this century. It was formerly more like the reed of the shawm, an instrument from which the oboe has been derived; and that of the present bassoon. It is now made narrower, with much advantage in the refinement of the tone. As in the flute, the notes up to C sharp in the treble clef are produced by the normal blowing, and simply shortening the tube by opening the sound-holes. Beyond that note, increased pressure, or overblowing, assisted by an harmonic "speaker" key, produces the first harmonic, that of the octave and so on. The lowest notes are rough and the highest shrill; from A to D above the treble clef, the tone-quality of the oboe is of a tender charm in melody. Although not loud, its tone is penetrating and prominent. Its staccato has an agreeable effect. The place of the oboe in the wood wind band between the flute and the clarinet with the bassoon for a bass, is beyond the possibility of improvement by any change.

Like the flute, there was a complete family of oboes in the 16th and early in the 17th century; the little schalmey, the discant schalmey, from which the present oboe is derived; the alto, tenor, pommer, and bass pommers, and the double quint or contrabass pommer. In all these old finger-hole instruments the scale begins with the first hole, a

note in the bagpipe with which the drones agree, and not the entire tube. From the bass and double quint pommers came ultimately the bassoon and contra-bassoon, and from the alto pommer, an obsolete instrument for which Bach wrote, called the oboe di caccia, or hunting oboe, an appellation unexplained, unless it had originally a horn-like tone, and was, as it has been suggested to me by Mr. Blaikley, used by those who could not make a real hunting horn sound. It was bent to a knee shape to facilitate performance. It was not exactly the cor Anglais or English horn, a modern instrument of the same pitch which is bent like it, and of similar compass, a fifth below the usual oboe. The tenoroon, with which the oboe di caccia has been compared, was a high bassoon really an octave and a fifth below. It has been sometimes overlooked that there are two octaves in pitch between the oboe and bassoon, which has led to some confusion in recognising these instruments. There was an intermediate instrument a third lower than the oboe, used by Bach called the oboe d'amore, which was probably used with the cornemuse or bagpipe, and another, a third higher than the oboe, called musette (not the small bagpipe of that name). The cor Anglais is in present use. It is a melancholy, even mournful instrument, its sole use in the orchestra being very suitable for situations on the stage, the effect of which it helps by depressing the mind to sadness. Those who have heard Wagner's "Tristan und Isolde" will remember, when the faithful Kurwenal sweeps the horizon, and sees no help coming on the sea for the dying Tristan, how pathetically the reed pipe of a careless peasant near, played in the orchestra on a cor Anglais, colours the painful situation.

The bassoon is the legitimate bass to the oboe and to the wood wind in general. It was evolved in the 16th century from the pommers and bombards: the tenors and basses of the shawm or oboe family. With the older instruments, the reeds were not taken hold of immediately by the lips, but were held in a kind of cup, called *pirouette* which only allowed a very small part of the reed to project. In the oboe and bassoon the player has the full control of the reed with the lips, which is of great importance, both in expression and intonation. The bassoon economises length, by being turned back upon itself; and, from its appearance, obtains in Italy and Germany the satirical appellation of "fagotto" or "fagott." It is made of wood, and has not, owing to many difficulties as yet unsurmounted, undergone

those changes of construction that have partly transformed other wood wind instruments. From this reason—and perhaps the necessity of a bassoon player becoming intimately familiar with his instrument—bassoons by some of the older makers—notably, Savory—are still sought after, in preference to more modern ones. The instrument, although with extraordinary advantages in tone, character, and adaptability, that render it valuable to the composer, is yet complicated and capricious for the performer; but its very imperfections remove it from the mechanical tendencies of the age, often damaging to art; and, as the player has to rely very much upon his ear for correct intonation, he gets, in reality, near to the manipulation of the stringed instruments. The bassoons play readily with the violoncellos, their united tone being often advantageous for effect. When not so used, it falls back into its natural relationship with the wood wind division of the orchestra. The compass of the bassoon is from B flat, an octave below that in the bass clef, to B flat in the treble clef, a range of three octaves, produced by normal pressure, as far as the bass clef F. The F below the bass clef is the true lowest note, the other seven semitones descending to the B flat being obtained by holes and keys in the long joint and bell. These extra notes are not overblown. The fundamental notes are extended as in the oboes and flutes by overblowing to another octave, and afterwards to the twelfth. In modern instruments yet higher notes, by the contrivance of small harmonic holes and cross fingerings, can be secured. Long notes, scales, arpeggios are all practicable on this serviceable instrument, and in full harmony with clarinets, or oboes and horns, it forms part of a rich and beautiful combination. There is a very telling quality in the upper notes of the bassoon of which composers have made use. Structurally, a bassoon consists of several pieces, the wing, butt, long joints, and bell, and when fitted together they form a hollow cone of about eight feet long, the air column tapering in diameter from three-sixteenths of an inch at the reed, to one and three-quarter inches at the bell end.

The bending back at the butt joint is pierced in one piece of wood, and the prolongation of the double tube is usually stopped by a flattened oval cork, but in some modern bassoons this is replaced by a properly curved tube. The height is thus reduced to a little over four feet, and the holes, assisted by the artifice of piercing them obliquely, are brought within

reach of the fingers. The crook in the end of which the reed is inserted, is about twelve inches long, and is adjusted to the shorter branch.

The contra-bassoon is an octave lower than the bassoon, which implies that it should go down to the double B flat two octaves below that in the bass clef, but it is customary to do without the lowest, as well as the highest notes of this instrument. It is rarely used, but should not be dispensed with. Messrs. Mahillon, of Brussels, produce a reed contra-bass of metal, intended to replace the contra-bassoon of wood, but probably more with the view of completing the military band than for orchestral use. It is a conical brass tube of large proportions with seventeen lateral holes of wide diameter and in geometrical relation, so that for each sound one key only is required. The compass of this contra-bass lies between D in the double bass octave and the lower F of the treble clef.

The sarrusophones of French invention are a complete family, made in brass and with conical tubes pierced according to geometric relation, so that the sarrusophone is more equal than the oboe it copies, and is intended, at least for military music, to replace. Being on a larger scale the sarrusophones are louder than the corresponding instruments of the oboe family. There are six sarrusophones from the soprano in E flat to the contra-bass in B flat; and to replace the contra-bassoon in the orchestra there is a lower contra-bass sarrusophone made in C, the compass of which is from the double bass octave B flat to the higher G in the bass clef.

Before leaving the double reed wind-instruments, a few words should be said of a family of instruments in the 16th century as important as the schalmey, pommers, and bombards, but long since extinct. This was the cromorne, a wooden instrument with cylindrical column of air; the name is considered to remain in the cremona stop of the organ. The lower end is turned up like a shepherd's crook reversed, from whence the French name "tournebout." Cromorne is the German "krumhorn;" there is no English equivalent known. The tone, as in all the reed instruments of the period, was strong and often bleating. The double reed was enclosed in a *pirouette*, or cup, and the keys of the tenor or bass, just the same as with similar flutes and bombards, were hidden by a barrel-shaped cover, pierced with small openings, apparently intended to modify the too search-

ing tone as well as to protect the touch-pieces which moved the keys. The compass was limited to fundamental notes, and from the cylindrical tube and reed was an octave lower in pitch than the length would show. In all these instruments, provision was made in the holes and keys for transposition of the hands according to the player's habit of placing the right or left hand above the other. The unused hole was stopped with wax. There is a fine and complete set of four cromornes in the Museum of the Conservatoire at Brussels.

We must also place among double-reed instruments the various bagpipes, cornemeuses, and musettes, which are shawm or oboe instruments with reservoirs of air, and furnished with drones enclosing single reeds. I shall have more to say about the drone in the third lecture. In restricting our attention to the Highland bagpipe, with which we are more or less familiar, it is surprising to find the peculiar scale of the chaunter, or finger-pipe, in an old Arabic scale, still prevailing in Syria and Egypt. Dr. A. J. Ellis's lecture on "The Musical Scales of Various Nations," read before the Society of Arts, and printed in the *Journal of the Society* 27th March, 1885, No. 1,688, volume xxxiii., and in an Appendix, 30th October, 1885, in the same volume, should be consulted by any one who wishes to know more about this curious similarity.

We have now arrived at the clarinet. Although embodying a very ancient principle—the "squeaker" reed which our little children still make, and continued in the Egyptian argheel—the clarinet is the most recent member of the wood-wind band. The reed initiating the tone by the player's breath, is a broad, single, striking or beating reed, so called because the vibrating tongue touches the edges of the body of the cutting or framing. A cylindrical pipe, as that of the clarinet, drops, approximately, an octave in pitch when the column of air it contains is set up in vibration by such a reed, because the reed virtually closes the pipe at the end where it is inserted, and, like a stopped organ pipe, sets up a node of maximum condensation or rarefaction at that end. This peculiarity interferes with the resonance of the even numbered partials of the harmonic scale, and permits only the odd-numbered partials, 1, 3, 5, and so on, to sound. The first harmonic, as we find in the clarinet, is therefore the third partial, or twelfth of the fundamental note, and not the octave, as in the oboe and flute. In the oboe the shifting of

the nodes in a conical tube open at its base, and narrowing to its apex, permits the resonance of the complete series of the harmonic scale, 1, 2, 3, 4, 5, and upwards. The flute has likewise the complete series, because through the blowhole it is a pipe open at both ends. But while stating the law which governs the pitch and harmonic scale of the clarinet, affirmed equally by observation and demonstration, we are left at present with only the former when regarding two very slender, almost cylindrical reed-pipes, discovered in 1889 by Mr. Flinders Petrie, while excavating at Fayoum, the tomb of an Egyptian lady named Maket. Mr. Petrie dates these pipes about 1100 B.C., and they were the principal subject of Mr. Southgate's recent lectures upon the Egyptian scale. Now Mr. J. Finn, who made these ancient pipes sound at these lectures with an arghool reed of straw, was able upon the pipe which had, by finger holes, a tetrachord, to repeat that tetrachord a fifth higher by increased pressure of blowing, and thus form an octave scale, comprising eight notes! "Against the laws of Nature," says a friend of mine, for the pipe having dropped more than an octave through the reed, was at its fundamental pitch, and should have overblown a twelfth. But Mr. Finn allows me to say with reference to those reeds, perhaps the oldest sounding musical instruments known to exist, that his experiments with straw reeds seem to indicate low, medium, and high octave registers. The first and last difficult to obtain with reeds as made by us. He seeks the fundamental tones of the Maket pipes in the first or low register, an octave below the normal pitch. By this the fifths revert to twelfths. I offer no opinion, but will leave this curious phenomenon to the consideration of my friends Mr. Blaikley, Mr. Victor Mahillon, and Mr. Hermann Smith, acousticians intimate with wind instruments.

The clarinet was invented about A.D. 1700, by Christopher Denner, of Nuremberg. By his invention, an older and smaller instrument, the chalumeau, of eleven notes, without producible harmonics, was, by an artifice of raising a key to give access to the air-column at a certain point, endowed with an harmonic series of eleven notes a twelfth higher. The chalumeau being a cylindrical pipe, the upper partials could only be in an odd series, and when Denner made them speak, they were consequently not an octave, but a twelfth above the fundamental notes. Thus, an instrument which ranged with the help of eight finger-holes and two keys, from F in the bass

clef to B flat in the treble, had an addition given to it at once of a second register from C in the treble clef to E flat above it. The scale of the original instrument is still called *chalumeau* by the clarinet player; about the middle of the last century it was extended down to E. The second register of notes, which by this lengthening of pipe started from B natural, received the name of clarinet, or clarionet, from the *clarino* or *clarion*, the high solo trumpet of the time it was expected that this bright harmonic series would replace.

This name of clarinet, or clarionet, became accepted for the entire instrument, including the *chalumeau* register. It is the communication between the external air and the upper part of the air column in the instrument which, initiating a ventral segment or loop of vibration, forces the air-column to divide for the next possible partial, the twelfth, that Denner has the merit of having made practicable. At the same time the manipulation of it presents a difficulty in learning the instrument. It is in the nature of things that there should be a difference of tone-quality between the lower and upper registers thus obtained; and that the highest fundamental notes, G sharp, A and B flat, should be colourless compared with the first notes of the overblown series. This is a difficulty the player has to contend with, as well as the complexity of fingering, due to there being no less than eighteen sound-holes. Much has been done to graft Boehm's system of fingering upon the clarinet, but the thirteen key system, invented early in this century by Iwan Müller, is still most employed. The increased complication of mechanism is against a change, and there is even a stronger reason, which I cannot do better than translate, in the appropriate words of M. Lavoix fils, the author of a well-known and admirable work upon instrumentation:—

"Many things have still to be done, but inventors must not lose the point in view, that no tone-quality is more necessary to the composer than that of the clarinet in its full extent; that it is very necessary especially to avoid melting together the two registers of *chalumeau* and clarinet, so distinct from each other. If absolute justness for these instruments is to be acquired at the price of those inestimable qualities, it would be better a hundred times to leave it to virtuosi, thanks to their ability, to palliate the defects of their instrument, rather than sacrifice one of the most beautiful and intensely coloured voices of our orchestra."

There are several clarinets of various pitches, and formerly more than are used now, owing

to the difficulty of playing except in handy keys. In the modern orchestra the A and B flat clarinets are the most used; in the military band, B flat and E flat. The C clarinet is not much used now. All differ in tone and quality; the A one is softer than the B flat; the C is shrill. The B flat is the virtuoso instrument. In military bands the clarinet takes the place which would be that of the violin in the orchestra, but the tone of it is always characteristically different. Although introduced in the time of Handel and Bach those composers made no use of it. With Mozart it first became a leading orchestral instrument.

The Basset horn which has become the sensuously beautiful alto clarinet in E flat, is related to the clarinet in the same way that the *cor Anglais* is to the oboe. Basset is equivalent to Baryton (there is a Basset flute figured in *Prætorius*), and this instrument appears to have been invented by one Horn, living at Passau, in Bavaria, about 1770. His name given to the instrument has been mistranslated into Italian as *Corno di Bassetto*. There is a bass clarinet employed with effect by Meyerbeer in the "*Huguenots*," but the characteristic clarinet tone is less noticeable; it is, however, largely used in military bands. The Basset horn had the deep compass of the bass clarinet which separates it from the present alto clarinet, although it was more like the alto in calibre. The alto clarinet is also used in military bands; and probably what the Basset horn would have been written for, is divided between the present bass and alto clarinets.

Preceding the invention of the *sarrusophone* by which a perfected oboe was contrived in a brass instrument, a modified brass instrument, the *saxophone*, bearing a similar relation to the clarinet, was invented in 1846 by Sax, whose name will occur again and again in connection with important inventions in military band instruments. The *saxophone* is played like the clarinet with the intervention of a beating reed, but is not cylindrical; it has a conical tube like the oboe. The different shape of the column of air changes the first available harmonic obtained by overblowing to the octave instead of the twelfth; and also in consequence of the greater strength of the even harmonics, distinctly changing the tone-quality. The *sarrusophone* may fairly be regarded as an oboe or bassoon; but the *saxophone* is not so closely related to the clarinet. There are four sizes of *saxophone* now made between high soprano and bass. Starting from the

fourth fundamental note, each key can be employed in the next higher octave, by the help of other two keys, which, being opened successively, set up a vibrating loop. The *saxophones*, although difficult to play, fill an important place in the military music of France and Belgium, and have been employed with advantage in the French orchestra. The fingering of all *saxophones* is that attributed to Boehm.

The cup-shaped mouthpiece must now take the place of the reed in our attention. Here the lips fit against a hollow cup-shaped reservoir, and, acting as vibrating membranes, may be compared with the vocal chords of the larynx. They have been described as acting as true reeds. Each instrument in which such a mouthpiece is employed requires a slightly different form of it. The French horn is the most important brass instrument in modern music. It consists of a body of conical shape about seven feet long, without the crooks, ending in a large bell, which spreads out to a diameter of fifteen inches. The crooks are fitted between the body and the mouthpiece: they are a series of smaller interchangeable tubings, which extend in length as they descend in pitch, and set the instrument in different keys. The mouthpiece is a funnel-shaped tube of metal, by preference, silver; and, in the horn, is exceptionally not cup-shaped, but the reverse: it tapers, as a cone, from three-quarters of an inch diameter to about a minimum of three-sixteenths of an inch, and is a quarter of an inch where the smaller end of the mouthpiece is inserted in the upper opening of the crook. The first horn has a mouthpiece of rather less diameter than the second. The peculiar mouthpiece and narrow tubing have very much to do with the soft voice-like tone-quality of the horn. For convenience of holding, the tubing is bent in a spiral form. There is a tuning-slide attached to the body, and, of late years, valves have been added to the horn, similar to those applied to the cornet and other wind instruments. They have, to a considerable extent, superseded hand-stopping, by which expedient the intonation could be altered a semitone or whole tone, by depression of the natural notes of the instrument. In brass, or other instruments, the natural harmonics depend upon the pressure of blowing; and the brass differs entirely from the wood-wind, in this respect, that it is rare, or with poor effect, the lowest or fundamental note can be made to sound. Stopping the horn is done by extending the open hand some

way up the bore; there is half stopping and whole stopping, according to the interval, the half tone or whole tone required. As may be imagined, the stopped notes are weak and dull compared with the open. On the other hand, the tubing introduced for valves not being quite conformable in curve with the instrument, and hampered with indispensable joints, unless in the best form of modern valve, affects the smoothness of tone. No doubt there has been of late years a great improvement in the manufacture of valves. Many horns are still made with crooks covering an octave from B flat to B flat, 8 feet 6 inches to 17 feet; but most players now use only the F crook, and trust to the valves, rather than to change the crooks, so that we lose the fullness of sound of those below F. The natural horn was originally in D, but was not always restricted to that key; there have been horns for F, G, high A, and B flat. This may, however, be said for the valve horn, that it does not limit or restrict composers in writing for the open or natural notes, which are always more beautiful in effect.

Valves were invented and first introduced in Prussia about A.D. 1815. At first there were two, but there are now generally three. In this country and France they are worked by pistons, which, when pressed down, give access for the air into channels or supplementary tubings on one side of the main bore, thus lengthening it by a tone for the first valve, a semitone for the second, and a tone and a semitone for the third. When released by the finger the piston returns by the action of a spring. In large bass and contralto instruments, a fourth piston is added, which lowers the pitch two tones and a semitone. By combining the use of three valves, lower notes are obtained—thus, for a major third, the second is depressed with the third; for a fourth, the first and third; and for the tritone, the first, second, and third. But the intonation becomes imperfect when valves are used together, because the lengths of additional tubing being calculated for the single depressions, when added to each other, they are too short for the deeper notes required. By an ingenious invention of compensating pistons, Mr. Blaikley, of Messrs. Boosey's, has practically rectified this error without extra moving parts or altered fingering. In the valve section, each altered note becomes a fundamental for another harmonic scale. In Germany a rotary valve, a kind of stop-cock, is preferred to the piston. It is said to give

greater freedom of execution, the closeness of the shake being its best point, but is more expensive and liable to derangement. The invention of M. Adolphe Sax, of a single ascending piston in place of a group of descending ones, by which the tube is shortened instead of lengthened, met, for a time, with influential support. It is suitable for both conical and cylindrical instruments, and has six valves, which are always used independently. However, practical difficulties have interfered with its success. With any valve system, however, a difficulty with the French horn is its great variation in length by crooks, inimical to the principle of the valve system, which relies upon an adjustment by aliquot parts. It will, however, be seen that the invention of valves has, by transforming and extending wind instruments, so as to become chromatic, given many advantages to the composer. Yet it must, at the same time, be conceded, in spite of the increasing favour shown for valve instruments, that the tone must issue more freely, and with more purity and beauty, from a simple tube than from tubes with joinings and other complications, that interfere with the regularity and smoothness of vibration, and, by mechanical facilities, tend to promote a dull uniformity of tone-quality.

Owing to the changes of pitch by crooks, it is not easy to define the compass of the French horn. Between C in the bass clef, and G above the treble, will represent its serviceable notes. It is better that the first horn should not descend below middle C, or the second rise above the higher E of the treble clef. Four are generally used in modern scores. The place of the horn is with the wood-wind band. From Handel, every composer has written for it, and, what is known as the small orchestra of string and wood-wind bands combined, is completed by this beautiful instrument.

The most prominent instruments that add to the splendour of the full orchestra are trumpets and trombones. They are really members of one family, as the name trombone—big trumpet—implies, and blend well together. The trumpet is an instrument of court and state functions, and, as the soprano instrument, comes first. It is what is known as an eight-foot instrument in pitch, and gives the different harmonics from the third to the twelfth, and even to the sixteenth. It is made of brass, mixed metal, or silver, and is about five feet seven inches in real length, when intended for the key of F without a slide; but is twice turned back upon itself, the first and

third lengths lying contiguous, and the second about two inches from them. The diameter is three-eighths of an inch along the cylindrical length; it then widens out for about fifteen inches, to form the bell. When fitted with a slide for transposition—an invention for the trumpet in the last century—this double tubing, about five inches in length on each side, is connected with the second length. It is worked from the centre with the second and third fingers of the right hand, and, when pulled back, returns to its original position by a spring. There are five crooks. The mouthpiece is hemispherical and convex, and the exact shape of it is of great importance. It has a rim with slightly rounded surface. The diameter of the mouthpiece varies according to the player and the pitch required. With the first crook, or rather shank, and mouthpiece, the length of the trumpet is increased to six feet, and the instrument is then in the key of F. The second shank transposes it to E, the third to E flat, and the fourth to D. The fifth, and largest—two feet one a half inches long—extends the instrument to eight feet, and lowers the key to C. The slide is used for transposition by a semitone or a whole tone, thus making new fundamentals, and correcting certain notes of the natural harmonic scale, as the seventh, eleventh, and thirteenth, which do not agree with our musical scale. Mr. W. Wyatt has recently taken out a patent for a double-slide trumpet, which possesses a complete chromatic scale. In the required length of slide the ear has always to assist. It is clear that the very short shifts of a double-slide demand great nicety of manipulation. It is, of course, different with the valve trumpet. The natural trumpets are not limited to one or two keys, but those in F, E, E flat, D, B flat, and even A have been employed; but, usually, the valve trumpets are in F, and the higher B flat, with a growing inclination, but an unfortunate one, to be restricted to the latter, it being easier for cornet players. The tone of the high B flat trumpet cannot, however, compare with the F one, and with it the lower notes are lost. Of course, when there are two or three trumpets, the high B flat one finds a place. However, the valve system applied to the trumpet is not regarded with satisfaction, as it makes the tone dull. For grand heroic effect, valve trumpets cannot replace the natural trumpets with slides, which are now only to be heard in this country.

The simple, or field trumpet, appears to exist now in one representative only, the E flat

cavalry trumpet. Bach wrote for trumpets up to the twentieth harmonic—but for this the trumpet had to be divided into a principal, which ended at the tenth harmonic—and the clarino in two divisions, the first of which went from the eighth harmonic up to as high as the player could reach, and the second clarino, from the sixth to the twelfth. The use of the clarinet by composers about the middle of the last century seems to have abolished these very high trumpets. So completely had they gone, by the time of Mozart, that he had to change Handel's trumpet parts, to accommodate them to performers of his own time, and transfer the high notes to the oboes and clarinets.

Having alluded to the cornet à piston, it may be introduced here, particularly as from being between a trumpet and a bugle, and of four foot tone, it is often made to duty for the more noble trumpet. But the distinctive feature of this, as of nearly all brass instruments since the invention of valves, tends to a compromise instrument, which owes its origin to the bugle. The cornet à piston is now not very different from the valve bugle in B flat on the one hand, and from the small valve trumpet in the same key, on the other. It is a hybrid between this high-pitch trumpet and the bugle, but compared with the latter it has a much smaller bell. By the use of valves and pistons with which it was the first to be endowed, the cornet can easily execute passages of consecutive notes that in the natural trumpet can only be got an octave higher. It is a facile instrument, and double tonguing, which is also possible with the horn and trumpet, is one of its popular means for display. It has a harmonic compass from middle C to C above the treble clef, and can go higher, but with difficulty. A few lower notes, however, are easily taken with the valves.

We now come to the trombones, grand, sonorous tubes, which, existing in three or four sizes since the 16th century, are among the most potent additions on occasion to the full orchestra. Their treble can be regarded as the English slide trumpet, but it is not exactly so. There appears to have been as late as Bach, a soprano trombone, and it is figured by Virdung, A.D. 1511, as no larger than the field trumpet. The trumpet is not on so large a calibre, and in the 17th century had its own family of two clarinos and three tubas. The old English name of the trombone is sackbut. The old wooden cornet, or German zinke, an obsolete, cupped-mouthpiece instrument, the real bass of which, according to family, is the

now obsolete serpent, was used in the 16th and 17th centuries as the treble instrument in combination with alto, tenor, and bass trombones. The leading features of the trumpet are also found, as already inferred, in the trombone; there is the cupped mouthpiece, the cylindrical tubing, and, finally, a gradual increase in diameter to the bell. The slide used for the trumpet appears for four centuries and probably longer, in the well-known construction of the trombone. In this instrument it consists of two cylindrical tubes parallel with each other, upon which two other tubes communicating by a pipe at their lower ends curved in a half circle, glide without loss of air. The mouthpiece is fitted to an upper end, and a bell to a lower end of the slide. When the slide is closed, the instrument is at its highest pitch, and as the column of air is lengthened by drawing the slide out, the pitch is lowered. By this contrivance a complete chromatic scale can be obtained, and as the determination of the notes it produces is by ear, we have in it the only wind instrument that can compare in accuracy with stringed instruments. The player holds a cross-bar between the two lengths of the instrument, which enables him to lengthen or shorten the slide at pleasure, and in the bass trombone, as the stretch would be too great for the length of a man's arm, a jointed handle is attached to the cross-bar. The player has seven positions, each a semitone apart for elongation, and each note has its own system of harmonics, but in practice he only occasionally goes beyond the fifth. The present trombones are the alto in E flat, descending to A in the seventh position; the tenor in B flat descending to E; the bass in F descending to B, and a higher bass in G descending to C sharp. Wagner, who has made several important innovations in writing for bass brass instruments, requires an octave bass trombone in B flat; an octave lower than the tenor one, in the "*Nibelungen*." The fundamental tones of the trombone are called "pedal" notes. They are difficult to get and less valuable than harmonics because, in all wind instruments, notes produced by overblowing are richer than the fundamental notes in tone-quality. Valve trombones do not, however, find favour, the defects of intonation being more prominent than in shorter instruments. But playing with wide bore tubas and their kindred is not advantageous to this noble instrument.

The serpent has been already mentioned as the bass of the obsolete zinken or wooden

cornets, straight or curved, with cupped mouthpiece. It gained its serpentine form from the facility given thereby to the player to cover the six holes with his fingers. In course of time keys were added to it, and when changed into a bassoon shape its name changed to the Russian bass horn or *basson Russe*. A Parisian instrument maker, Halary, in 1817, made this a complete instrument, after the manner of the keyed-bugle of Halliday, and producing it in brass called it the *ophicleide*, from two Greek words meaning serpent and keys—keyed serpent—although it was more like a keyed bass bugle. The wooden serpent has gone out of use in military bands within recollection, the *ophicleide* from orchestras only recently. It has been superseded by the development of the valved tubas. The euphonium and bombardon, the basses of the important family of saxhorns, now completely cover the ground of bass wind instrument music. The keyed-bugle, invented by Joseph Halliday, bandmaster of the Cavan militia, in 1810, may be regarded as the prototype of all these instruments, excepting that the keys have been entirely replaced by the valve system, an almost contemporary invention by Stölzel and Blümel, in Prussia, in 1815. The valve instruments began to prevail as early as 1850. The sound tube of all bugles, saxhorns, and tubas is conical, with a much wider curve than the horn. The quality of tone produced is a general kind of tone, not possessing the individuality of any of the older instruments. All these valve instruments may be comprehended under the French name of *saxhorn*. There is a division between them of the higher instruments or bugles, which do not sound the fundamental note, and of the lower, or tubas, which sound it readily. Properly military band instruments, the second or bass division, has been taken over to the orchestra; and Wagner has made great use of it in his great scores. The soprano cornets, bugles, or *flügelhorns* and saxhorns are in E flat; the corresponding alto instruments in B flat, which is also the pitch of the ordinary cornet. The tenor, baryton, and bass instruments follow in similar relation; the bass horns are, as I have said, called tubas; and that with four valves, the euphonium. The bombardon, or E flat tuba, has much richer lower notes.

For military purposes, this and the contrabass—the *helicon*—are circular. Finally, the contrabass tubas in B flat, and in C, for Wagner, have immense depth and potentiality of tone; all these instruments are capable of *pianissimo*.

There are many varieties now of these brass instruments, nearer particulars of which may be found in Gevaert, and other eminent musicians' works on instrumentation. One fact I will not pass by, which is that, from the use of brass instruments (which rise in pitch so rapidly under increase of temperature, as Mr. Blaikley has shown, almost to the co-efficient of the sharpening under heat in organ pipes), has come about that rise in pitch, which, from 1816 to 1846—until repressed by the authority of the late Sir Michael Costa, and, more recently, by the action of the Royal Military College at Kneller-hall—is an extraordinary feature in musical history. All previous variations in pitch—and they have comprised as much as a fourth in the extremes—having been due either to transposition, owing to the requirements of the human voice, or to national or provincial measurements. The manufacture of brass instruments is a distinct craft, although some of the processes are similar to those used by silversmiths, coppersmiths, and braziers.

I have only time to add a few words about the percussion instruments which the military band permits to connect with the wind. Drums are, with the exception of kettle drums, indeterminate instruments, hardly, in themselves, to be regarded as musical, and yet important factors of musical, and especially rhythmic effect. The kettle drum is a cauldron, usually of brass or copper, covered with a vellum head bound at the edge round an iron ring, which fits the circle formed by the upper part of the metal body. Screws working on this ring tune the vellum head, or vibrating membrane as we may call it, by tightening or slackening it, so as to obtain any note of the scale within its compass. The tonic and dominant are generally required, but other notes are, in some compositions, used; even octaves have been employed. The use Beethoven made of kettledrums may be regarded among the particular manifestations of his genius. Two kettle drums may be considered among the regular constituents of the orchestra, but this number has been extended; in one remarkable instance, that of Berlioz in his Requiem, to eight pairs. According to Mr. Victor de Pontigny, whose article I am much indebted to (in Sir George Grove's Dictionary) upon the drum, the relative diameters, theoretically, for a pair of kettle drums are in the proportion of 30 to 26, bass and tenor; practically the diameter of the drums at the French opera is 29 and 25½ inches—and of the Crystal Palace band, 28 and 24½ inches. In cavalry regiments

the drums are slung so as hang on each side of the drummer's horse's neck. The best drum sticks are of whale bone, each terminating in a small wooden button covered with sponge. For the bass drum and side drum I must be content to refer to Mr. Victor de Pontigny's article, and also for the tambourine, but the Provençal tambourines I have met with have long, narrow sound bodies, and are strung with a few very coarse strings which the player sounds with a hammer. This instrument is the rhythmic bass and support to the simple galoubet, a cylindrical pipe with two holes in front and one behind, sounded by the same performer. The English pipe and tabor is a similar combination, also with one player, of such a pipe, and a small drum-head tambourine. Lastly, to conclude percussion instruments, cymbals are round metal plates, consisting of an alloy of copper and tin—say 80 parts to 20—with sunk hollow centres, from which the Greek name. They are not exactly clashed together to elicit their sound, but rubbed across each other in a sliding fashion. Like the triangle, a steel rod, bent into the form indicated by the name, but open at one corner so as to make it an elastic rod, free at both ends; the object is to add to the orchestral matter luminous crashes, as it were, and dazzling points of light, when extreme brilliancy is required.

In conclusion, I must be allowed to express my obligations to Dr. W. H. Stone and Mr. Victor Mahillon, to Mr. Ebenezer Proul, Mr. Richard Shepherd Rockstro, Mr. Lavoix fils, and Dr. H. Riemann, whose writings concerning wind instruments have materially helped me; to Messrs. Boosey and Co., and to Messrs. Rudall, Carte and Co., for the loan of the instruments used in the illustrations; and also to Mr. D. J. Blaikley and Mr. Henry Carte, for valuable personal aid on the present occasion. Their kindness in reading through my manuscript—Mr. Blaikley throughout—and in offering friendly and generous criticisms; also their presence and assistance by trial of the various instruments, I cannot adequately thank them for, or sufficiently extol.

(In the course of this lecture, Mr. Henry Carte played upon a concert flute, also a B flat and a G flute, an eight-keyed flute, and a recorder. Mr. D. J. Blaikley continued the illustrations upon the oboe, bassoon, clarinet, French horn, slide trumpet, valve tenor horn, cornet à pistons, B flat tenor slide trombone, B flat euphonium, B flat contrabass tuba, and B flat contrabass double slide trombone.)

Miscellaneous.

VITICULTURE IN PALESTINE.

The United States Consul at Jerusalem says that competent judges among the foreign colonists there are of opinion that the agricultural success of Palestine depends largely on its vine-producing capacity. At the present time, the cultivation of the vine brings from 40 to 50 per cent. better returns than does that of any other product of the soil. As a consequence, each succeeding year more and more land is planted with vineyards, and various improvements are introduced and new experiments tried. The German and Jewish colonies around Jaffa and in its neighbourhood are as yet the chief fields for this industry, and the best wine is made there. Extensive ancient vineyards of native culture are, however, still seen at Eshcol and Ramallah, and at other places in the vicinity of Jerusalem and Bethlehem. There can be little doubt, says Consul Gillman, that at no distant day, vineyards will cover the hill-sides of Judea to such an extent as has never been previously known. A curious feature in connection with vine-growing is that, from the blossoming to the perfecting of the grape, not a drop of rain falls to moisten the soil. This perhaps explains how the fruit never suffers from mildew, as in other countries. At or towards sunset each evening, a cool westerly wind generally rises, bringing up with it during the night a mist from the Mediterranean, which sufficiently waters the parched ground, but there is no excess of moisture. Neither are the vines afflicted with the diseases which have proved such a scourge in France and in some other wine-producing countries. New varieties of the vine are being constantly introduced from other countries, and greater quantities of wine manufactured, though the native species are still in preponderance as to amount, and form the chief source of supply. These last produce chiefly a most delicious fruit, varying from a green to a pale or golden yellow colour, the bunches and the single grapes being usually of a large size. There is also a native grape of a purple tint, and of close or small cluster and rather sharp flavour, from which the red wine of the country, somewhat resembling claret, is made. Probably, however, from want of proper culture and improvement, no very distinctive varieties have arisen from any of the native species. A method of grafting the grape vine has been successfully introduced into Palestine by some German settlers at Sarong, and this has also been adopted by the Jewish colonists at Beshon-Zion, both places being in the neighbourhood of Jaffa. They graft, on the native stocks, shoots of American, French, and Hungarian extraction, the first mentioned variety being commonly the American Isabella grape. This

is generally done in the month of February, though it is sometimes delayed until March. Although in the United States the Isabella is not a highly esteemed variety, being, on the contrary, rather one of the inferior grapes, under the warm sun and cloudless skies of Palestine it becomes a superior fruit, an excellent wine being made from it.

General Notes.

HISTORY OF THE SOCIETY.—The attention of members interested in the early history of the Society of Arts may be drawn to a series of articles in *Engineering* on "London Societies." These commenced with the Royal Society, the history of which, from its foundation in 1660 down to the present time, was in eight articles, published during May and June. The next society treated was the Society of Arts, the second oldest of the institutions in this country dealing with scientific matters. The first article on it appeared in *Engineering* for the 24th July, and the series is being continued weekly.

SHIPPING ON THE AMERICAN LAKES.—From a report just issued from the Census Bureau at Washington, we learn that in five years the number of ships trading on the American lakes has increased from 1,997 to 2,055, and the tonnage has gone up from 634,652 tons, to 826,360 tons. While, therefore, the number has increased by 2·9 per cent., the tonnage has been augmented by 30 per cent., showing that the average size of the vessels has greatly increased—from 698 to 745 tons. Screw steamers over 1,500 tons have increased fivefold, there being now 110 of 188,390 tons, while the number between 1,000 and 1,500 tons has doubled, being 151,611 tons. In the substitution of steel for iron as a constructive material, progress has also been made. Five years ago there were but 6,459 tons of shipping of steel, now there are nearly 100,000 tons. Composite ships are in increasing favour, being a satisfactory compromise in view of the extensive forests of wood available. Iron is practically stationary at 24,673 tons of shipping, but wooden vessels have also increased in numbers, but to no great extent. It is still remarkable, however, that about 80 per cent. of the lake vessels are of wood. The yearly tonnage is now about 27,500,000 tons, and assuming the average voyage to be 566 miles, the ton mileage is 15,578 millions, equal to about 23 per cent. of the ton mileage of all American railroads. Coal made up a proportion of 28 per cent. of the total tonnage, iron over 24 cent., lumber 23·8 per cent., agricultural produce 16·5 per cent., products of various mines and quarries 2·2 per cent., and general freight 5·5 per cent. The figures given do not include the trade to or from Canadian ports.—*Engineering*.

Journal of the Society of Arts.

No. 2,021. VOL. XXXIX.

FRIDAY, AUGUST 14, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

Forms of application for space, and prospectuses with detailed information, will not be issued till October, but, in the meantime, intending exhibitors can apply to the Secretary of the Society of Arts, and their names will be noted at once, with a view to their receiving early copies of the prospectus when ready.

The Secretary, Sir Henry Trueman Wood, has been instructed by the Council to visit Chicago at once; and he will leave England for this purpose in the first week of September. Exhibitors who are likely to require special arrangements made for them—such, for instance, as relate to permission to erect special buildings in the grounds—would do well to communicate with him before his departure.

Proceedings of the Society.

CANTOR LECTURES.

MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.

BY A. J. HIPKINS, F.S.A.

Lecture III.—Delivered February 9, 1891.

Having described in the previous lectures those musical instruments (whether string, pipe, or reed) which belong to such combinations as the orchestra and military band, we will now consider those furnished with keyboards, by

which they are manipulated; and, as this contrivance originates a fresh order of treatment, I have decided to group keyboard instruments as a separate class. Without the keyboard, music, in its modern European development, would hardly have been known, the orchestra might not have progressed beyond the Hungarian gipsy band, and there would have been no organ to aid religious service, or support choral masses in harmony; and the facilities for the composer the pianoforte offers would have been wanting. Indeed, there can be no doubt that the keyboard, by the privilege it gives for the trial of several voices or parts, has helped to build up counterpoint, and, ultimately, harmony.

Before proceeding to the various instruments that are accessible, by the keyboard, to full harmony in any combination of notes, it will be well to consider the keyboard alone, and to try to make out its history. Like all inventions that have required time for their recognition, and an ever-widening use to bring out their importance, the record is imperfect, and the materials fragmentary, that can throw light upon its development. Its origin was either in the organ, when an aggregate of pitch-pipes only, or in connection with the monochord, the normal mediæval pitch-measure. It is accepted that organs, hydraulic or otherwise, existed in the time of the Roman domination, and may have been of Greek invention. In the 8th and 9th centuries, organs were heard of in England, France, and Germany; but, up to the 11th century, there appears to have been no use made of balanced levers, or keys to produce the notes. Sliding rods, like modern draw-stops, seem, from the imperfect notices existing, to have been the only means for obtaining and controlling sound from the pipes. As single notes only were practicable, there could have been no harmony whatever, unless two persons, drawing out slides simultaneously, could have set two notes going. There are three ways open to us to trace historically the construction and improvement of musical instruments, or whatever appertains to them. The sure one is the examination and comparison of existing instruments; the next is found in graphic representations, to be valued according to the realistic or conventional treatment the draughtsman may employ. The last and least satisfactory is that of written description, the difficulties of which are made more perplexing by the confusion attending names used by writers in different places and at different times. With the early keyboard

we are only left with such indications as we can get from pictorial or written evidence, as no known keyboard is older than the end of the 15th century. At this point of our inquiry we ought not to overlook the keys of the hurdy-gurdy or vielle, the viol sounded by a wheel instead of a bow. The fact of this instrument having strings tuned as drones puts back its origin to when the drone was the only addition to melody.

The bagpipe was the wind instrument similarly burdened, and there is every reason to believe that the drone early became characteristic of the organ. It is a principle of great antiquity, perhaps prehistoric, still existing in the East, and particularly in India. The keys of the hurdy-gurdy are simply slides pushed back by the player, with projections to stop the strings and produce notes according to the vibrating length required; and as the instrument is held with the keys downwards, these slides when released, fall back by their own weight. It is possible that the hurdy-gurdy keys suggested the contrivance of balanced levers for stopping the monochord, and thus the clavichord, a complex of monochords, for at first the strings of it were of equal length, came about; but it is equally possible that the invention of balanced lever keys was earliest applied to the organ. We have to step with great care in this inquiry. Of what happened, if anything, in the 11th and 12th centuries concerning keyboards, we know nothing. The first glimmering of light is in the 13th century. At that epoch a small portable organ for processional use, a shrill pitch giver and little more, had been invented. One of the valuable results of the Music Division of the Inventions Exhibition of 1885 was the publication of important books concerning music and musical instruments, two of which were undertaken by Mr. Quaritch. The one I now particularly refer to is entitled "Notes on Early Spanish Music," with illustrations of 13th and 14th century instruments. The author is Don Juan Riaño, who was the special commissioner appointed for Spain, in connection with the Music Loan Collection attached to that Exhibition. I had the great privilege to found that collection which was shown in the Royal Albert-hall, and was officially associated with it as chairman of the Special Loan Committee. I may also mention that I was honoured with a gold medal awarded by the Executive Council of the Exhibition for these services. In Don Riaño's book there is a drawing, copied from an authenticated manuscript

of the 13th century, in which a portable organ, or *portatif*, appears. It has nine pipes; but it has been sufficient to the artist to figure three keys, which are hardly keys, in the sense of levers, but evidently represent those gimlet-looking finger-stops, of which I shall give other instances. When depressed by the fingers, they lowered, by some internal contrivance, the valves or pallets necessary to admit wind to the pipes they served. There is no clue to the actual notes. The set of drawings this example is contained in belongs to the *codex* of the "Cantigas de Santa Maria," of which there are three manuscripts: one in the National Library, Madrid, and two in the library of the Escorial. The Spanish Royal Academy have just published this work; but, these interesting and important musical miniatures had already appeared in "Instrumentaria Española," by Don Francisco Aznar, Madrid, 1880.

I will defer the next illustration from Don Riaño's book, in order to continue with these finger stops, which evidently remained in use in portable organs after balanced keys had been employed. An instance of them may be seen in our own National Gallery, in an altarpiece by Orcagna, the date of which is given in the catalogue as A.D. 1357. The order of these stops is not clear, but seems to be chromatic, and the sharps are of the same colour as the naturals, not contrasted as afterwards became the custom. Another instance of such an instrument is found in a beautiful female figure, representing Music, depicted in a fresco, attributed to Taddeo Gaddi, and preserved in the Spanish chapel of Santa Maria Novella, Florence. She is represented as singing, while touching with her third finger one of these stops. There are two rows of stops, as in Orcagna's altarpiece; and that the back and upper one is chromatic, I entertain no doubt. It is true that the back row appears to have as many stops as the front one, as may be seen in Mr. Timothy Cole's woodcut of the figure in the *Century Magazine*, March, 1889. This artist has since favoured me with a photograph of the painting, to prove the accuracy of his engraving, so it may be assumed either that Taddeo Gaddi has not cared to be exact or that some of the finger-stops were dummies. Fifteenth century illustrations of similar stops may be seen in *portatifs*, depicted by Memling in paintings preserved in the hospital of St John, at Bruges. The accuracy of these delineations is unquestionable as is also the complete chromatic order of the stops. One

of these representations of a *portatif* is in a painting in the famous shrine of St. Ursula; the other and larger in the "Marriage of St. Catherine." The latter is dated 1479, but the instruments represented may have been already old when the painter selected them for delineation. I now return to Don Riaño's next illustration of a *portatif*, which is different. It is copied from a fresco, an altarpiece in the Cistercian Monastery of Nuestra Señora de Piedra, Aragon, and is dated 1390. Here is shown a *portatif* with three rows of pipes and balanced white natural keys, with one square chromatic key let in. Assuming that the treble of the instrument terminates at A, which occurs in 15th century positive organs, and recognising the necessity in the plain song of a B flat for transposition, we cannot be wrong in regarding this square key as that note. If there is another B flat an octave lower, which according to Guido's scale was likely to be the case, the hand of the player covers it. Viridung, in 1511, figures a diatonic keyboard with two B flats, but this drawing is not altogether to be relied upon as an exact representation. There was such keyboards no doubt, only of an older fashion. Fra Angelico, who was painting in the first half of the 15th century, represents *portatifs* with diatonic keyboards, and, in one important instance, a dubious indication of incidental upper keys. I think, however, it is proved that full chromatic keyboards were in contemporary use with diatonic ones, including B flat, which was reckoned a diatonic note in the 14th and 15th centuries.

With regard to the keyboards of large church organs, I cannot do better than briefly summarise the information on them, supplied by Prætorius in the second volume, "De Organographia," of his great work entitled "Syntagma Musicum," and published at Wolfenbüttel, A.D. 1618; it was completed by the Theatrum Instrumentorum seu Sciagraphia, that is to say, the illustrative plates, A.D. 1620.

I will pass by what he says about the earliest organs in churches, because he is not speaking from personal knowledge, to start with the famous old Halberstadt organ with which he was familiar. This organ was built, according to inscriptions upon it, in A.D. 1361, and renovated in A.D. 1495. Whatever happened in this renovation we shall find that the manual keyboards and compass of keys were undisturbed, and that probably the pedal keyboard was original, but as to this doubt may be allowed. The compass of the two highest

keyboards was the same, and exactly that of the ancient Greek scale of fourteen natural notes, extending from B natural in the bass clef, "hypate hypaton," to A in the treble clef, "nete hyperbolæon." Thus proving that the church organ keyboard was a scholastic conception in the first instance, and we shall find it, although afterwards only partially, for some time adhered to, and with Pythagorean, which was a non-harmonic tuning. The fifteenth natural key in that conception was the B flat near middle C, which belonged to the conjunct tetrachord, "trite synnemon." But the necessities of the transposition of the plain song to accommodate voices, for which we have the authority of Arnold Schlick, who published his book in the same year as Viridung, A.D. 1511, had brought about the intercalation of the chromatic keys or "ficti" as they were then called—feigned notes—and consequently the restricted compass of the Halberstadt organ was, I have no doubt about it, originally chromatic. The lowest manual was a bass keyboard from an approximately 32 foot B natural, to 16 foot C. The highest was for the mixture, various pipes of different but related pitches sounding together when a key was put down, without any attempt to sort them into various registers. In fact, the first essay in this direction is here seen, in the speaking pipes in the front of the organ, the "Principal," as it was called, being on the second or intermediate keyboard apart from the mixture, and on the third or bass manual connected with the large deep bass pipes in the side towers. This principal was a four-foot stop, the measure of an English principal of the present day, and it is curious that this old German tradition has really been maintained in England while it has not in Germany, where the eight-foot foundation register is now the principal. We call the eight-foot foundation stops diapasons—that is to say octaves below our principal, diapason being the Greek equivalent for octave. I can hardly accept the explanation which derives this name from an organ-builder's rule, inasmuch as though called diapason, his rule would serve to measure any pipe in any register. I believe the deep third keyboard pipes were originally used for drones, and to keep such notes continuously sounding was how pedals first came into use. We call a drone now a pedal point, and composers use it, especially for the tonic or dominant, with great effect. The Halberstadt pedals were for bass notes to the mixture, and were mixture

notes themselves, although without the highest rows of pipes. We may consider the pipes in the side towers were also upon the pedals, but as to this the text is not clear. If the usually received statement, that pedals were invented by Bernhard, organist to the Doge of Venice, in A.D. 1470, then the Halberstadt pedals were no older than the renovation; but, I think, we may safely follow the suggestion of Prætorius that pedals had been long in use in Germany, and were only introduced by Bernhard at that date into Italy. They were not generally adopted in other parts of Italy, or in England either, until the present century. The compass of the Halberstadt pedals was only an octave: B natural, C, C sharp, D, D sharp, E, F, F sharp, G, G sharp, A, and B flat. We learn from Schlick that B flat had been the highest pedal key, and some inconvenience had been caused to organists by changing this note to B natural.

Now, the Halberstadt keys were very wide: on the two upper keyboards, four inches from centre to centre of each key, with chromatic keys two inches wide, placed two and a half inches above the diatonic. The keys of the two discant manuals were rounded, but in the bass keyboard they were square. I am indebted to Dr. Hopkins for these measurements, which are given in his valuable article upon the organ in Sir George Grove's dictionary, and, I presume, are founded upon Prætorius's text and drawings. There could be, with this keyboard, no question of stretching an octave with the extended hand, or even more than a major third, and, what we call fingering, was entirely out of the question. The organist used the side of his clenched hand to depress the keys.

I will now briefly show, from Prætorius, the gradual upward extension of compass; but, for a long while, the B natural in the bass clef remained the starting note, according, as I have said, to the old Greek scale. It would appear that the pitch of the renovated Halberstadt organ was about a tone above our medium pitch of C, 528 double vibrations a second; but the pre-Reformation B natural was a fourth higher than this Halberstadt pitch, as was the case in the old Magdeburg organ, which was still remaining in Prætorius's time. We have seen that the Halberstadt organ had no higher key than the old Greek A in the treble clef. Prætorius describes the keyboard of the church organ of St. Egidius, at Brunswick, the date of which was A.D. 1456, as permitting the stretch of a fifth, instead of a major third, as at Halber-

stadt. He gives a drawing, but, unfortunately, not the compass of the Brunswick keyboard; but he does of another organ of the same period, that of St. Salvator, at Vienna. In this the manual compass extended to C in the treble clef; the pedals as at Halberstadt. An undated organ at Minden, with keys $2\frac{1}{2}$ inches wide, according to Prætorius's own measurement, had the same compass, pedal and manual, as this Venetian organ. The next quoted by him was the organ of St. Sebald, at Nuremberg. Here the pedals went down to the lower A of the bass clef, the "Greek proslambanomenos," with B flat also added, but the manual kept to the normal B natural, ascending, however to treble clef D. Another by the same builder, Heinrich Traxdorff, was in the Church of our Lady at Nuremberg, without pedals, and only ascending in the manual to the Halberstadt A, but he introduced the octave register in the St. Sebald organ, and presumably in this, in addition to the already separated principal; the mixture remaining as the Hintersatz or Back organ. A further extension was made by Krebs and Mülner in the organ at Mildenberg, where the manual was advanced to the higher F of the treble clef; the lowest bass key still remaining B natural but the pedal starting from A, and from thence to the A above, a chromatic octave. We are now nearing the period of a great change in the organ keyboard, when Conrad Rotenburger built, about A.D. 1475, the great organ at Bamberg, with similar compass, but to change it eighteen years later, that is in A.D. 1493, to the "long measure" in the bass, for the pedals, F, G, A, B flat, and then from B natural, chromatically, to the B flat above the bass clef, altogether an octave and a fourth; and for the manuals from the same F below the bass clef, to A above the treble, three octaves and a third. The width of the keys was gradually being lessened until, when Cranz, in A.D. 1499, built the great organ of St. Blaise, at Brunswick, the octave was only the width of nine keys of Prætorius's time, when the octave had come to be comfortably grasped, as it has remained ever since, by an average hand. I ought here to state the compass of a modern German organ, and will take that of the great organ of Ulm, built by Walcker of Ludwigsburg, and accounted one of the finest German instruments. The manual keyboards, three in number, go from C below the bass clef to F above the treble, fifty-four notes, and the pedals from the octave lower C to D in the bass clef, 27 notes. Large

organs built in this country exceed this compass. Messrs. Hill's Sydney organ has five octaves, from C to C, on all five manuals sixty-one notes, and pedals from C to F, thirty notes.

From the end of the 15th century the drone bass notes, as tonics or dominants to an octave system, appear to have got the better of the scholastic tetrachordal idea of the scale. Where the long measure, as it may be called, to the low F was not carried out on the keyboard, it was, in fact, as far as possible by substitution of pipes. The B natural key served no longer for that note, but for the G below it; the C sharp key doing duty for A; and the D sharp, when not retained for E flat, for B natural; but as this was hardly a drone note, E flat was often preferred. This was the short measure — for 300 years the well-known "short octave." In Italy the short octave has remained quite up to the present time, but generally with E for the apparently lowest key, which really sounds C, as F sharp sounds D and G sharp E; neither of these chromatics being good drone notes. Long drone pipes may be observed in pictures in which are represented the old portatifs, or processional organs, as in the Orcagna altarpiece and the Spanish 14th century miniature I have mentioned. I can give many examples. And, in the Cecilia panel by the Van Eycks, painted for the Church of St. Bavon, Ghent, but now at Berlin, a positive or small chapel organ is painted in the most realistic manner, and the lowest note, D, has a special key situated below the keyboard at the left-hand side, while above this key there is a latch, the only possible use for which could have been to fix a drone. Perhaps the deep drones came later into large church organs on account of the greater cost of the deep bass pipes.

It will now be interesting to trace the general history of the organ up to that epoch when it may be regarded as a complete instrument. We learn from Prætorius that the back organ, or huge mixture, as I have said, of many pipes to a key, was about the time of Luther's Reformation and translation of the Bible, dissected by the contrivance of separating rows of pipes of different degrees of pitch, as 16-foot, 8-foot, 6-foot, 4-foot, and so on, into registers by means of slides acted upon by drawstops. About this time, also, pipes which had all previously been open from the mouthpiece to the upper end, were supplemented by certain registers of covered or stopped pipes closed at the upper end, thereby introducing

the contrast of a quieter and less penetrating tone-quality. These stopped pipes were an octave lower in pitch than open pipes of the same length, from an acoustical reason that a node is formed at the closed end of the pipe, and thus the wave length becomes equivalent to twice the wave length of an open pipe corresponding in length. An important structural change, such as the formation of independent registers, was soon taken advantage of for introducing contrasts of various tone-qualities. Improved methods of wind supply, and, as has been explained, an extended manual compass with narrower keys admitting of an octave being grasped, an extended pedal compass, and lastly, the invention of reed-stops, which Prætorius places about A.D. 1530, made the 16th century organ complete in all essentials; but to be improved upon, added to, and transformed, until, in the present day, it has become a triumph of tone, colour, and effective combination, and of mechanical skill, assisted by pneumatics and electricity.

The sketch of a complete organ is as follows: A wind-supply, pumped by hand labour, hydraulic power, or gas, the air being compressed, as well as collected, from the bellows, is conveyed to the wind chests, where it remains until liberated for use by the player. The top of the wind chest, upon which the pipes stand, is called a sound-board, but has nothing to do with resonance; and the pallets, or valves of the channels of air which lead to the pipes, are closed until acted upon by the key mechanism, which is under the control of the player. The action of a key with the old tracker movement is very simple: when the player puts one down, the other end of the balanced lever raises a sticker, which acts upon mechanism governing what is technically and expressively called a "pull down" attached to the pallet. Formerly, the weight of a touch, and consequent amount of force required from the player, was in direct proportion to the increase of weight from the accumulation of tracker movements; but by contrivances to equalise wind pressure, and particularly by the pneumatic lever, the invention of the late Mr. Barker, who also invented an electric action, the touch of the organ may be as light, with any number of stops drawn, as that of a piano or harmonium. The pneumatic lever is a small-power bellows attached to each key, and supplied with high-pressure wind by the key being put down. The service of this invaluable lever is auxiliary to the finger in raising the

action. The pipes are of metal or wood, those of metal being a mixture of tin and lead, and are either flue-pipes with mouth-pieces, or reed-pipes, in which is enclosed a vibrating tongue of metal. Flue-pipes may be, as already mentioned, open or stopped at the upper end. Their length and size varies with the pitch of the note; and their scale and form of air column varies according to the quality of tone required. The air, entering a metal flue-pipe from a wind-chest, is arrested by a flat piece of metal, called the "languid," and, being diverted by it in its direction, is forced through the mouth between an under and an upper lip, the latter being a fine bevelled and indented edge, against which the wind, thus directed, breaks into a state wherein, according to Mr. Hermann Smith's theory, suction alternates with compression, and that portion which goes into the pipe sets up isochronous vibrations, that, agreeing with the period of vibration of the pipe, make the note, and last as long as the pallet remains open. In a wooden pipe the air is divided by a wooden block, performing the same office as the metal "languid." This is the same in principle as the flute player's *embouchure*. His breath passes from the throat, through the mouth and lips, against a sharp edge, giving access to the air contained in the flute. The effective length of an open pipe is measured from the languid to the upper end of the pipe, and in a stopped pipe from the block to the stopper and back again. In the reed pipe the foot is a metal case called a boot. In the boot is a round piece of metal also called a block, pierced in two places, the larger of which contains the reed, and the smaller the tuning wire which regulates the length of the tongue or reed so as to give the true note. The complete reed is a brass tube, in which there is a narrow opening, covered by a tongue of the same metal, the lower end of which is free to vibrate. Air when admitted to the tube forces the tongue away from the orifice, to which it returns by its own elasticity, and the puffs of air thus ejected, establish the note, their rapidity determining its pitch. The length and shape of the tube affect the tone quality. As the tongue when at rest covers the opening, unlike that of the harmonium which is free of such contact, it is known as a beating or striking reed. By the operation of slides which exclude or admit air to whole rows of pipes, are formed the registers or varieties of pitch, power, and tone-quality, governed by the draw stops. Each of these is really a separate instrument, but bands of them, so to

speak, which have certain affinities, are grouped into departments, under control of separate keyboards, called the great, choir, swell, solo, and pedal organs. Not all necessarily in one instrument, especially the solo. Mechanical couplers and composition pedals, the latter the invention of the late Mr. Bishop, assist the player in his combinations. In adapting the pneumatic principle to these mechanical arrangements Mr. Henry Willis has done very much to facilitate performance upon large organs. The great organ has the typical pipes of the organ, the diapasons, and in England, before pedal organs were introduced, which was not as already said effectively done until the beginning of the present century, were upon a light wind and of a fine mellow quality. The different balance of power in the modern organ has unfortunately yet unavoidably done away with this musical excellence. As well as these foundation stops there are gathered upon the great organ, all those stops, flue and reed, that are most brilliant, as well as the mixtures. And also the reed trumpets and clarion, of 16, 8, and 4-foot stops, which have great richness and power. The choir organ contains stops of lighter character, and carries with it the idea of accompaniment, as the name implies. The swell organ has grown into very great importance on account of the expression gained by its being in a box with Venetian shutters, which, when closed, materially reduce the tone, and as they open, produce an effective crescendo. The swell organ is entirely of English origin, and the expedient of *louvre*s or Venetian shutters, in use for the last hundred years, is an adaptation of the harpsichord Venetian swell, invented in 1769 by Burkhard Tschudi, the founder of the house of Broadwood. It is now well known in France, and is there called *Récit*. It is less known in Germany.

The chief advocate for the extended introduction of the swell-box in this country is Mr. G. A. Audsley, who has not only urged it on logical grounds in his treatise on "Concert, Church, and Chamber Organs," published in the columns of the *English Mechanic*, (1886-8), and his recent lectures on the "Swell in the Organ," but has practically proved the great advantages to be secured by the multiplication of expressive departments in the organ. About twenty-five years ago he schemed and constructed his own chamber organ, which was when finished, and still remains, for its size, the most flexible and ex-

pressive pipe organ existing. This can easily be understood when it is known that out of its nineteen speaking stops fifteen are rendered expressive by being inclosed in swell-boxes. The two expressive divisions of the great organ, on the lower clavier, are enclosed in two independent swell-boxes; the only stop here unincluded being the *principale grande* (open diapason 8 feet). The upper or choir manual being entirely expressive. The range of expressive effects and *nuances* secured by these means is remarkable, while the tone qualities of the stop remain unaffected. Mr. Audsley now advocates inclosing a portion of the pedal organ to make the bass also expressive. Amongst organ builders of the present time, Mr. Roosevelt, of New York, makes the greatest use of the swell-box. For instance, in his organ recently erected in the auditorium at Chicago, he has, out of its eighty-six manual-speaking stops, rendered seventy-nine expressive by inclosing them in five separate swell-boxes.

The solo organ is quite modern. Its introduction is attributed to the late Cavaillé-Coll in France, and Mr. Hill in this country. The intention of the solo organ is to supply certain effective reed stops on exceptionally heavy wind. The pedal organ is the general bass to the whole instrument. In the largest instruments the 16-foot diapason and other stops are doubled by 32-foot open metal and reed stops, and Messrs. Hill and Son, in their great Sydney organ, have actually introduced a 64-foot reed, the harmonics of which blend in the general effect. To complete the pedal organ, softer stops are now required, of which Mr. Casson is the earnest and able advocate. The charm of a soft bass, in these days of mechanical progress and corresponding stress of life, seems to be everywhere disregarded. I cannot but think that the mechanical progress so wonderfully shown in the modern organ has now gone beyond the intrinsic musical value of the instrument, and attention should be given rather to the improvement of voicing and combining allied registers in suitable families, with the general advancement and proportioning of tone-quality, so as to secure a real economy of the various departments. With regard to the extraordinary inventions which have attached pneumatic and electric aid to the organ, something I think may still be said for the old tracker action, which does allow a player gifted with a fine sense of touch some personal control, through the pallet, over the tone denied to him when these natural

forces intervene. I should say mechanical ingenuity is not exhausted for ameliorating any difficulties presented by the old movement. I admit that the influence of personal touch on the organ is a debateable question; but I am not alone in upholding its possibility, and the occasional revelation of such a power in the player. The incompleteness of this sketch of the organ would, I am afraid, appear impertinent if I could not refer those who desire more information to the admirable articles by Dr. Hopkins, in Sir George Grove's "Dictionary of Music and Musicians;" by R. H. M. Bosanquet, in the "Encyclopædia Britannica," and one in Sir John Stainer's and Dr. Barrett's "Dictionary of Musical Terms."

In the 17th century, and perhaps the 16th, an interesting offshoot of the organ was the regal, a complete reed stop taken from it and used as a separate instrument for accompaniment in convents and elsewhere. These beating reed instruments are now very scarce. I believe I possess the only large Regal in this country; it is an almost portable *Vox Humana*. The regal might have been regarded as the prototype of the harmonium, had there not been an unbridged gap between the discontinuance of the regal, which became entirely forgotten, and the invention of the harmonium and its congeners, which did not happen until the present century had come in. The principle of the harmonium is the free reed, the opposite to the beating reed of the organ, the regal, or clarinet. The tongue does not touch the frame surrounding it, and the action of the air in the harmonium is to force it away, and in a now favourite variety of that instrument, the American organ, by suction from, the opening, to which it returns by its own elasticity, thus setting up, by puffs of air, isochronous vibrations. The inventor of the principle of the harmonium was a Frenchman, Grenié, who, early in this century, contrived a free-reed keyboard instrument, and called it *orgue expressif*. The invention was completed in 1840 by the late M. Debain, who introduced air channels, to control tone-quality, and gave his instrument the name of harmonium. It had an air reservoir, to ensure a uniform wind pressure. M. Alexandre, also of Paris, gave the player the discretion of doing without this reservoir, by letting the wind supply act, by means of an expression stop, directly upon the reeds, thereby giving the harmonium a power of expression it had not before. The harmoniums of Mustel, of Paris, are the most expensive and the most admired.

The American organ, which acts by wind exhaustion, is said to have emanated from Alexandre's, but was first made popular in America. The tone is softer, and of less characteristic tone-quality than that of the harmonium, and the expression stop is wanting.

Mr. Casson informs me that, by a pressure-regulating screw of his invention, he can give the harmonium and American organ, an almost indefinite gradation of power, from *pianissimo* to *fortissimo*; and that the valve is so sensitive, that a slight trembling of the finger on a key will produce a vibrato. If this is carried out, the harmonium will be much increased in importance as an artistic instrument. In another direction, that of purity of intonation, an harmonium has been invented by a Japanese amateur, Mr. Shohé Tanaka, called by him, from a suggestion of Dr. Hans von Bülow, "Enharmonium," which, by dividing the octave into twenty keys, increased by a simple mechanical contrivance giving enharmonic changes, governed by a knee lever to twenty-six notes, obtains with certain scarcely perceptible limitations, absolute purity of intervals and chords; and by a transposing movement, effective throughout the range of the whole chromatic octave, all keys with their modulations are played in the C major or A minor position. The value of this instrument, the fingering of which, owing to the transposition, is not difficult, for choral accompaniment, is evident. The instrument has really thirty-six distinct vibrations in each octave, of which only twenty-six are utilised in any one position of the transposed keyboard.

Before proceeding to the last instrument of which I have to treat, the pianoforte, it will be interesting to go back to its precursors, the clavichord, spinet, or virginal, and harpsichord. The use that has been made of all these instruments, and their common possession of strings, resonance-boards, and keyboards makes the clavier instruments a group apart, but of the highest importance to the historical development of music. The original member of this group was probably the clavichord, but it is an inference only, from the simplicity of its construction and the certainty that it was based upon the mediæval monochord. The invention is nowhere recorded. The earliest reference that has been met with to a clavier instrument has recently been discovered by Mr. Edmond Vander Straeten, a well-known Belgian musical archæologist. It is to be found in the seventh volume of his great work,

"La Musique aux Pays-Bas." It appears that, in A.D. 1387, King John of Aragon requested his brother-in-law, Philip the Hardy, to procure for him a musical instrument which he calls "exaquir;" and in repeating this request the following year, he describes it as "resembling an organ, but mounted with strings." He also asks for a player able to touch both organ and "exaquir." There has been a musical instrument mentioned in 15th century French poetry long waiting for identification—the "echiquier." There can be but little doubt, according to Spanish and French phonology, of the identity of these names. Curiously enough there is a German form, "schachtbret," in some old rules of the Minnesingers, bearing date A.D. 1404. Whether this organ with strings was a virginal or clavichord we cannot say, but the name "echiquier"—"chequers"—may have come from an alternated colour of the keys, or perhaps from a pattern upon the case of the instrument, as is seen on some old portatifs. Both clavichord and spinet or virginal were known in the 15th century, and the latter had certainly, and the clavichord presumably, attained a useful degree of completeness. There is no clavichord so old known to exist, but an Italian trapeze spinet-shaped one was shown in the Paris Exhibition of 1889, dated A.D. 1547. This is the earliest I know of. The clavichord came from the monochord by adjusting a keyboard to a set of monochord strings, that is to say, strings of the same length and pitch, like an Æolian harp is made, and stopping them by little brass up-rights, a little widened at the top where they came in contact with the strings, these stoppers—which not only excited the sound but acted as bridges—being called tangents. There was only one wooden bridge, that on the narrow sound-board; a strip of cloth interwoven among the strings prevented any jarring on the further side of the tangents, and also damped the strings all along, when the tangents by the return of the keys quitted them. The strings were early attached in pairs, similar to the lute and other stringed instruments. By making the keys twisted, two, three, or even four tangents were made to act on one pair of strings. At the beginning of the 18th century the clavichord got its full number of strings, each pair having its own tangent, and this was the clavichord of Bach, a gentle instrument which best renders the tender sentiment with which much of his keyboard music is charged.

The spinet was the application of the keyboard to the mediæval psaltery, a form of dulcimer but with plectra, not hammers. The oldest known spinet is dated A.D. 1490, and was shown in 1888 at the Bologna Exhibition. Existing records show how much this instrument came into favour about that epoch. When, in 1509, the Chevalier Bayard, the famous knight without fear or reproach, was severely wounded at the siege of Brescia, he was carried to the house of a nobleman whose wife and daughter nursed him and entertained him during his convalescence by playing to him upon the lute and *espinette*, as the French call the spinet. The upright spinet was called "clavicytherium." I am of opinion that the beautiful upright spinet Mr. Donaldson owns, obtained from the Correr collection, and shown in the Loan Collection of 1885, although undated, may be as old as the 1490 spinet of Count Manzoni. There is an exact drawing of it by Mr. William Gibb, in my "Musical Instruments, Historic, Rare and Unique" (A. and C. Black, 1888). The spinet had one string only to each note, and the sound was excited by a little point of quill projecting at a right angle from a wooden upright placed upon the end of the key and called a Jack. This also bore a little cloth damper. According to Scaliger the quilled plectra were introduced in his boyhood. He was born A.D. 1484. Buff leather was introduced in later years but never superseded the use of crow quills. Perhaps brass wire preceded the quill points, as Mr. Donaldson's upright spinet certainly had such plectra. After the 16th century the musical value of the spinet hardly increased, but it gained somewhat in power, and was a brilliant instrument compared with the clavichord. Extended lengthways into the grand piano shape, and with two, three, and sometimes four strings to a note, generally with one string an octave higher in pitch, more rarely one an octave lower or bourdon, the spinet thus multiplied early became the more powerful and important harpsichord. Double keyboards and stops for registers showed its affinity, at least in idea, to the organ. The harpsichord certainly existed in the 16th century; there is one in South Kensington Museum, dated A.D. 1521; it died out with the spinet and clavichord in the last quarter of the 18th, unable to maintain the struggle for existence against the piano. Perhaps the last harpsichord was one bearing Clementi's name, dated 1802, which was also shown at the Bologna Exhibition. Beethoven's "Moonlight" sonata was

published in 1802 for harpsichord or pianoforte, and there is record that Himmel played upon a harpsichord in public, at Berlin, as late as 1805. All the keyboard stringed instruments, whatever the size and however the sound may be produced, have certain structural peculiarities in common, and especially the apparatus for resonance, the barred sound-board, of cypress in the old Italian spinets, of spruce in the modern piano; all come under the same acoustic generalisation of resonance as Strad fiddles, Bologna lutes, or Andalusian guitars.

The pianoforte was invented by Cristofori, of Padua, in the first years of the 18th century, to satisfy the desire for a stringed clavier that should combine the expressiveness of the clavichord with the effectiveness of the harpsichord; it was, at first, a sufficiently facile instrument, and contained those principles of resonance—resistance to strain and suppleness of key action that still characterises it. Cristofori solved three important problems, the first of which was to counteract the strain of thicker strings necessary to withstand the impact of hammers. The second, allied to the first, was to compensate for the weakness caused by the opening between the tuning-pin block—technically, "wrest-plank"—and the sound-board, imperative for the hammers to rise to the strings. The third was the mechanical control of the rebound of the hammer from the strings—technically, "escapement"—so that the hammer should not block against the strings and prevent vibration. All this he did, and more, for he invented the check, or moveable rest for the hammer-tail, the simplest expedient to preserve the position of the hammer for a repeated blow—technically, "repetition." I am glad to be able to show models of Cristofori's actions, one made from the diagram in Scipione Maffei's account, published in the *Giornale dei Letterati*, A.D. 1709; the other, a remarkable piece of mechanism showing the check as well as the ingenious escapement, from grand pianos actually existing, dated 1720 and 1726. The much-talked-of pianos by Silbermann, acquired by Frederick the Great, and still at Potsdam, have Cristofori's action. Now if we raise the lid and look inside a modern grand piano, we shall see first the strings, three in number for each note, of cast steel wire—perhaps the strongest tensile material in the world—with length and diameter increasing from the treble to the bass, and single bass strings for the lowest notes, overspun with fine copper or white metal wire to

add to their weight, to make up for the strings in that part of the scale being theoretically too short. It may surprise some here to know that each of those three string notes, when up to the pitch of a London orchestra, has, in Broadwood's concert grand pianos, an average drawing power or tension of approximately 500 lbs., so that the notes have a strain, and that always when at that pitch, of nearly twenty tons. This large aggregate is exceeded by some foreign makers. To withstand this enormous strain, the strings are held at one end by coils round the tuning pins, which are driven into a strong structure of beech and wainscoat, called the wrest-plank; and at the other end are hitched upon smaller pins fixed into an iron or steel plate which is carried round the bent side to the end of the case. Their bearing points are upon the bridge attached to the soundboard, and the brass agraffes which collectively form the wrest-plank bridge. Bars of metal cross from the wrest-plank to the string-plate, and are so adjusted and fixed that the instrument proper is in an immovable iron frame. American and German makers have a single casting. Beneath the strings from where the hammers rise, to the bent side, back, and end of the case, is the soundboard of spruce fir, barred beneath with batons, usually of the same wood, technically "belly-bars," which strengthen the belly, and by increasing its elasticity, extend its power to form nodes or centres of vibration, and thus respond more promptly and effectively to the vibrations which are passed to it from the strings, when set in movement, through the hardwood belly bridge. A good soundboard reproduces all figures of vibration, however complex, exactly, and as freely as they are brought to the ear through atmospheric air, and reinforces them so that the almost inaudible sound of the wires becomes the satisfactory fulness of tone we hear when a good piano is played. All pianos, upon whatever system they are made, have the features I have just described in common, also a wooden substructure of heavy beams, which keeps the case intact and rigid; but there are differences of application which are the choice of the makers, and are sometimes of their invention. In Broadwood's concert grand, one diagonal bar bears the greater part of the strain, its angle to the string plate being disposed with that object, while Steinway's, and nearly all foreign grand pianos, have more bars, and the bass strings crossing the long steel strings, with the wider scale

and expanse of soundboard permitted by that disposition. For me, the tone of an overstrung bass is unduly powerful, and is open to the same objection I have touched upon in large organs that soft, pure, basses are not attainable. We have reached an aggregate of power in the grand piano that almost silences the stringed quartet, and even competes with the full orchestra. What we want is a pianoforte tone that gives us all the power and all the charm of varying *nuance* we can desire, with a tone-quality as specialised in character as the harpsichord tone was, that shall have the brightness and energy of vibration of the trumpet, without the blare.

I must pass by the advisability of iron frames in a single casting, for which the great convenience and popularity places my own want of faith at some disadvantage, to make some reference to the not less important question of the mechanism or action. The hammers attack the strings with an almost incredible variety of velocities, according to the player's scale of force. It is wider and more various in the English action, and is, therefore, more open to the characteristic individual feeling for tone; while Erard's action, which, in principle, is generally adopted abroad, is considered more facile for the pianist's *technique*.

The domestic upright piano is now restricted to the various modifications invented with the instrument about 1800, by Isaac Hawkins, and improved some sixty years since by Robert Wornum, the general merits of which have caused it to be, in these latter days, employed in every piano-making country.

The structure of smaller pianos is, in principle, the same as the concert grand. I have, in this lecture, preferred to deal with the general principles of piano construction, rather than to touch upon debateable points, which would take long to discuss, and could hardly be settled, inasmuch as piano making, like all other musical instrument making, is an art, and cannot be brought down to the level of mere mechanical manufacture. I think those who play the piano should have some acquaintance with those general principles, including that of sympathetic vibration, which the player controls with the pedals, a natural *Æolian* charm and prerogative of the instrument, divined by Beethoven, but the true use of which we owe to Chopin. I believe, if consideration were given to those principles more than it is, the unreasonable demands some players make upon this singularly responsive instrument might be reduced, and to the advan-

tage of the cultivation of a feeling for tone which is incumbent upon wind and other stringed instrument players, but is too frequently disregarded by those who play the piano.

I ought to refer the inquirer for further information about the construction of the piano to my paper upon it, read before the Society of Arts March 7th, 1883. It was published in the *Journal* of March 9th and (Appendix) September 21st of the same year. For this paper I received one of the Society's Silver Medals.

I have now an agreeable duty to perform in thanking Mr. Herbert Bowman, for the loan of his beautiful clavichord; Messrs. John Broadwood and Sons, for the loan of the harpsichord, and spinet, and the wrest-plank, belly, and model of action of a concert grand piano; Messrs. S. and P. Erard, for the loan of a model of their grand piano action; and Messrs. W. Hill and Son, for contributing a variety of interesting organ pipes, which show how different tone-qualities are produced. Illustrations of the organ, harmonium, and piano, are on this occasion scarcely necessary, but as few here can be familiar with either the clavichord or harpsichord—particularly the former—I will conclude by a performance on these instruments. I will play Bach's "Fantasia Cromatica" upon the clavichord. It was composed for this instrument, and may be said to rest upon the chromatic scale and its characteristic chords, the diminished seventh and ninth, resulting from equal temperament, and intolerable in the mean-tone. As this instrument demands absolute quiet, I will first play a prelude by the same composer, so as to accommodate the ear to the very limited sound. For the harpsichord I will play the double keyboard variations from Bach's 30 variations in G—known as the "Goldberg." I believe I play them for the first time in London, as recently, at Oxford, I played them for the first time in England. As the two keyboards must be of equal power I shall use the eight-foot registers. The four-foot, or octave, must be reserved for the last variation, the "Quodlibet," a humorous combination of two airs played on one keyboard; and I will use the octave also in the repetition of the air, which, according to the composer's intention, concludes the work. A drawing, published in the "*Zeitschrift für Instrumentenbau*," of a harpsichord which belonged to J. S. Bach, and was furnished with bourdon and octave registers, will be found among the pictorial illustrations I exhibit.

Miscellaneous.

CURING CODFISH IN FRANCE.

The consumption of fish in France is, says the United States Consul at Bordeaux, not only very considerable, but remains almost invariable, year in and year out. Fresh fish are eaten in quantity in the larger cities, at the seaports, and along the coasts, where they are plentiful, cheap, and always wholesome. In the interior, however, in the smaller and remote villages distant from both coast and water-way, and especially among the peasantry, preserved or salted fish must of necessity take the place of the freshly-caught article. In these last named districts, salt fish becomes the chief staple. At the port of Bordeaux alone, during the year 1890, there were discharged, from vessels of various nationalities, 61,136,165 lbs. of salt fish, the greater part of which was cod. Fresh codfish is a commodity unknown in France. *Morue verte* is the name given to that quality of fish prepared and salted aboard the Newfoundland fishing smacks, and barrelled and shipped in bulk to France. It is cooked and eaten after having been immersed in water for several hours. If, however, it is desirable to place upon the market for ordinary consumption a fish thoroughly cured, salted, and dried, the *morue verte*, which rapidly lose their virtue, are again dried, and undergo more careful preparation in France, from whence they are afterwards exported in great quantities to Spain, Italy, Belgium, Russia, and, in fact, to every country on the continent. The codfish industry is an important one in Bordeaux, where are annually prepared for general European and home consumption more than 12,000,000 cod, an equivalent of 20,000 tons, and representing in value £425,000. The establishments for codfish curing at Bordeaux are situated in the immediate neighbourhood of the city. At Begles, a little village, twenty-four separate factories are found. A distant view of these curing establishments, or rather the fields surrounding them, conveys, says Consul Knowles, the idea of a vast vineyard. Line upon line, row upon row of wooden and wire trellises, from three to four feet in height, extend across the plain as far as the eye can reach, and upon these rudely constructed frames, are hung innumerable fish, their split and divided surfaces exposed to the air. Upon receiving at the factories the roughly prepared fish, covered merely with a light layer of salt, adhering in crystals to the half moist surface, the first process consists of removing this incrustation with an ordinary hard scrubbing brush and cold water, the cod being placed and firmly held upon a rough pine table for the purpose. Until quite recently it has been customary in the various fish-drying establishments throughout the south-west or lowlands of France to cleanse the codfish by soaking the same in

water barrels for a protracted period, the method being more economical than beneficial. In the city of Bordeaux, municipal investigation a few years since into the fish-curing industry, proved the unhealthy results that might accrue from the repeated cleansing of salt fish in the same water, and every person engaged in the pursuit was obliged to lay mains or water conduits from the nearest or most convenient source of supply in order that fresh water alone might be employed. There have now been constructed within the majority of the factories, long narrow tanks or sluices, built of stone or marble, about 5 feet in width and 2 feet in depth. A continuous stream of water is forced through these tanks, usually by the aid of a one horse-power engine; and inspectors require that an average of 228 to 311 gallons of water shall be used in the cleansing of 2,200 lbs. of fish. At the sides are inclined deal board tables, at which those engaged in washing the fish kneel. After a vigorous and thorough scrubbing, the cod are laid aside in great piles, to await a day favourable to open-air exposure. Bright, clear weather, moderate temperature, and a slight north-easterly breeze are the most desirable conditions for drying. Codfish, when ready for shipment, are packed in bales of 110, 132, and 176 lbs., representing from 45 to 74 fish. Almost all of the smaller cod—those from 12 to 16 inches in length—are bought by and shipped to the Italian market. These also are of inferior quality, but they find a ready sale among the Italians. The largest quantity and best quality of cod are shipped to Spain. To the Italian markets the fish are sold with the black outer skin undetached; while to the Spanish they are not marketable unless this integument is removed. The fish-drying industry, in the immediate neighbourhood of Bordeaux, gives employment to about 600 people, each employing, on an average, 20 workmen; and, it may be roughly estimated, that these are capable of washing, cleaning, and drying 5,500 lbs. of fish every day. The men employed receive about 2s. 6d., and the women, who occupy themselves alone with removing the black skins of the fish, from 1s. 3d. to 1s. 8d. a day. The south of France is the principal market for prepared codfish. To Spain about 15,000 tons are annually exported; to Italy, about 2,000 tons. The Antilles, Algeria, and Portugal follow in their respective order.

ALUMINIUM IN STEEL INGOTS.

The effect of adding aluminium to steel ingots was discussed at considerable length at the recent meeting of the American Institute of Mining Engineers, communications on the subject by Professor J. W. Langley, of Pittsburg, and Professor J. O. Arnold, of Sheffield, being amongst the papers read. Professor Langley drew attention to the very small quantity of aluminium required to render steel casting perfectly sound. The aluminium is added in small

pieces of from $\frac{1}{4}$ lb. to $\frac{1}{2}$ lb. in weight, thrown on to the ladle during the tapping after a small quantity of steel is already in it. The aluminium melts almost instantaneously, and diffuses with great rapidity throughout the contents of the ladle. For open-hearth steel, containing less than .05 per cent. of carbon, 5 oz. to 10 oz. of aluminium are sufficient for each ton of steel, whilst for Bessemer steel the amount should be increased to from 7 oz. to 16 oz. per ton. For steel containing more than .50 per cent. of carbon the aluminium should be used cautiously in amounts of from 4 oz. to 8 oz. per ton. Professor Arnold described shortly the results of a number of experiments at the Sheffield Technical School, from which he concludes that the action of aluminium is about twenty times as powerful as that of silicon, and the resulting steel is tougher and sounder than when silicon is used, provided that certain precautions against piping are taken. He considers that the action of the aluminium is almost certainly chemical. The blow-holes in ingots are due to occluded gases, and it has been proved by experiment that aluminium readily reduces carbonic oxide at a temperature below that of melting steel. In one experiment Professor Arnold blew 40 gallons of pure carbonic oxide through a crucible of molten steel containing aluminium, with the result that the carbon in the steel was increased by 35 per cent., owing to the reduction of the gas. He concludes that by using aluminium, manganese can be dispensed with, and a considerable saving of time and fuel effected.—*Engineering*.

General Notes.

SOUTH KENSINGTON MUSEUM.—The designs submitted in competition for the completion of the buildings of the South Kensington Museum are now on view at the Museum from 10 to 6.

FRENCH WATCHES.—According to a report made by the Besançon Chamber of Commerce on the operations of the French watch industry, quoted in *The Engineer*, the anticipations formed in 1889 of an improving course of business were fully realised in 1890. Out of 404,436 watches of French manufacture delivered for consumption in 1890—of which about 30 per cent. were gold and 70 per cent. silver—no fewer than 401,439 were passed by the Besançon Control-office. Foreign watches to the number of 40,911 were passed as follows:—At Pontarlier, 22,557; Mothéliard, 10,986; Bellegarde, 3,859; Paris, 2,031; Besançon, 902; and all other offices, 576. Of the total foreign watches, 8,515 were gold and 32,396 silver. A comparison of the French watches with the foreign article shows that Besançon supplied 95.70 per cent. of the general consumption in 1890, against 89.51 per cent. in 1889, and 85.45 per cent. in 1888.

Journal of the Society of Arts.

No. 2,022. VOL. XXXIX.

FRIDAY, AUGUST 21, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

FOTHERGILL PRIZE.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire.

A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres or other places of public amusement.

In cases where the Invention is in actual use, reference should be made to places where it could be inspected.

A full description of the Invention, accompanied by such drawings or models as are necessary for its elucidation, must be sent in on or before the 31st December, 1891, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding the Prize, in case there is nothing in their opinion deserving the award, or sufficiently complying with the conditions sent in for competition.

Chicago Exhibition, 1893.

Forms of application for space, and prospectuses with detailed information, will not be issued till October, but, in the meantime, intending exhibitors can apply to the Secretary of the Society of Arts, and their names will be noted at once, with a view to their receiving early copies of the prospectus when ready.

The Secretary, Sir Henry Trueman Wood, has been instructed by the Council to visit Chicago at once; and he will leave England for this purpose in the first week of September. Exhibitors who are likely to require special arrangements made for them—such, for instance, as relate to permission to erect special buildings in the grounds—would do well to communicate with him before his departure.

THE MINT OF HINDUSTAN IN THE 16TH CENTURY.

BY ARTHUR WINGHAM.

In view of the recent satisfactory report of the Deputy-Master of her Majesty's Mint, and also of the improvements which have of late years taken place in the issue of coins from the Indian mints at Bombay and Calcutta, it is interesting to look back and read an account of the customs and regulations governing the mint of Hindustan in the 16th century. To anyone who is acquainted with the extreme accuracy and care which is bestowed upon the production and issue of coins at the Royal Mint—factors which render English coins, especially the gold ones, so acceptable in all parts of the world—and to anyone who can compare and appreciate the difference between the past and present methods of ensuring perfection, the following facts will be of more than passing interest. For them we are indebted to Akbar, the King of Hindustan from 1556 to 1605 A.D., who was a particularly clever administrator, and who affords us another example of that period of history which has left so many instances of greatness, and which seemed so universally prolific of genius. The great king's history and accounts of all his institutions were written by his vizier Abul Fazl, and finally published in Persian under the title of "Ayeen Akbery," from an English translation of which, by Francis Gladwin, published in 1800, the selections are made.

The officers of the mint were twenty-one in number, and the name and duties of each are mentioned from the "man of authority, knowledge and integrity to comprehend the whole" to the man who "carries away to his own house the sweepings of the mint, by the washing of which he gains a profit." The second principal officer was the "seraf, who is per-

fectly acquainted with the art of assaying metals, and who will execute the business of his office with honesty. In this glorious reign there are numbers of skilful serafs, and by the attention of his majesty gold and silver are refined to the highest degree of purity." The third officer is one "who is perfectly disinterested, to prevent anyone from acting with dishonesty." The remaining officers are the accountant, merchant, treasurer, weighman, melter, disc-cutter, stamper, and others of minor importance.

BUNWARY.

The process of the so-called assay is that of *bunwary*, or touch-needles. A series of standards, called *bannees*, similar in principle to our carat system, was made, the assays usually being within the range of from the standard known as $10\frac{1}{2}$ bannee, or pure metal, to that of $6\frac{1}{2}$ bannee. The standards were prepared as follows:—1 part, by weight, of pure silver, and the same quantity of pure copper were melted together, with 6 parts of gold of $10\frac{1}{2}$ bannee. The metal so obtained constituted $6\frac{1}{2}$ bannee. The standards from this to $10\frac{1}{2}$ bannee were 16 in number, and were made by successively replacing a 16th part of the alloy by the pure gold, each replacement constituting a standard one-quarter of a bannee higher than the previous one. The following Table shows the composition and the standard of the alloys:—

Parts by Weight.		Standard.	Approximate Fineness.
Composition.	Gold.		
8	0	$6\frac{1}{2}$ bannee	750
$7\frac{1}{2}$	$\frac{1}{2}$	$6\frac{3}{4}$ "	765.62
7	1	7 "	781.25
progressing regularly up to			
1	7	10 "	968.75
$\frac{1}{2}$	$7\frac{1}{2}$	$10\frac{1}{4}$ "	984.37
0	8	$10\frac{1}{2}$ "	1,000

The touch-needles therefore commanded a range in 16 equal divisions of metals having a fineness between 750 and 1,000. If a baser material was required, more silver and copper were mixed in; "but in the *bunwary* they do not assay lower than six bannee."

Our present system of carats is the division into 24 equal parts of metals, ranging in fineness from *nil* to 1,000. Thus, 24 carat is pure gold, and 18 carat gold is an alloy of 18 parts

of pure gold with 6 parts of other metal, generally copper, or a mixture of silver and copper. English standard gold for coinage is 22 carat, and its fineness, therefore, is $\frac{22}{24}$ ths of 1,000 = 916.6, the remainder being copper.

THE METHOD OF REFINING GOLD.

This consists in making the impure metal into plates six fingers in length and breadth, and, after washing the plates in water, stratifying them with a mixture of equal quantities of saltpetre and new brickdust, and covering the whole with *ouplah*, or cow-dung, which is then burnt. The plates are again twice covered and fired, when they are removed and washed. They are then treated to the same process, until they have been subjected to 6 stratifications and 18 fires. "Then the assay-master breaks one of the plates, and if there comes out a flat dead sound, it is a sign of its being sufficiently pure, otherwise it must again be stratified with the mixture, and undergo three more fires." It is then tested on the touchstone. Sometimes the purity is tested by making plates of equal weight of the refined metal and of pure gold, submitting them together to the above process, and again weighing, when, if the plates are of equal weight after this operation, the refined metal is considered pure. In another part it is stated that the refined gold is assayed by making a given weight into plates, stratifying and firing them as above, and then washing and melting them together. If the gold has lost nothing in weight by this operation, it is arrived at the "greatest degree of purity." The fee for an assay of this kind was one *dam* and ten *cheetels*: equal to a little over three farthings. The ashes from all these fires are kept, and silver recovered from them.

The refined metal is then cast into round ingots from which are cut pieces of the size of the coin. "It is surprising that in Iran and Turan they cannot cut these round pieces without an anvil made on purpose; and in Hindustan the workman, without any such machine, performs this business with such exactness that there is not the difference of a single hair." The discs are then placed between dies, and both sides stamped by one stroke of the hammer.

THE METHOD OF REFINING SILVER.

There are many methods described for refining silver. They all terminate with a kind of cupellation, which is performed in cupels made of the ashes of *babool* wood. "The

proofs of the metal being pure are the brightness thereof and its beginning to harden on the sides. When it is hardened in the middle they sprinkle it with water, when, if a flame issues from it, it is arrived at the desired degree of fineness . . . The coppel becomes a kind of litharge." The silver is then heated and hammered till it has "lost all smell of the lead."

The unrefined silver is contaminated with lead, tin, and copper. "The skilful can discover from the colour with what the superficial part is alloyed, and by the file and punch is learnt the quality of the inside. They also try it by heating it in the fire, when, upon throwing it into water, blackness denotes lead; redness, copper; and whitish cinder-colour, tin; and according as it is more or less white the greater or less is the proportion of silver."

THE PRODUCTION OF METALS.

"Metals are seven in number, viz. :—Gold, silver, *roohtoottea*, copper, tin, iron, and lead." *Foohtoottea* is said to be a kind of native pewter, but it will be seen later on that it was probably an alloy of lead, tin, and zinc. There are many alloys made of the above metals, of which the following are mentioned:—*Sefaid ru* (white brass), which is called by the natives of Hindustan *kansch*, and is composed of four parts of copper and one part of tin. *Rowee* is made of four parts of copper and one and a half part of lead (equal to 72·73 and 27·27 per cent. respectively). *Huft joash*, "where *roohtoottea* is not to be had, this is made of the other six metals; some call this *taleekoon*, and others take it to be a fictitious kind of copper." *Usht daht* is a composition of eight ingredients, viz., the six metals, with *roohtoottea* and *kansch*. *Seem suckhte* "is composed of silver, lead, and copper; it is of a deep colour, and very bright, and is used in silvering." It will be noticed that in the last three alloys no definite proportions of the metals are given. *Berinj* (brass) is made of two parts of copper and one and a half part of *roohtoottea*. Finally, *cowel putter* is composed of two parts of *sefaid ru* and one part of copper (equivalent to 86·7 per cent. of copper and 13·3 per cent. of tin). "This is a very elegant and beautiful composition, and is an invention of his present majesty."

In the preceding paragraphs I have confined myself almost entirely to the mere mention of facts as they appear in "Ayeen Akbery." I will

now compare them with some of more recent date. Truly may it be said that, the greater our knowledge the clearer is our perception of our own incapacities. Here we have the writers of 300 years ago talking freely of "pure" gold, and of refining it to the "highest degree" of purity by processes by which it would be almost impossible to purify higher than 99 per cent. Now, on the other hand, with all our improved methods of refining, Professor Roberts-Austen shows us that absolutely pure gold is rarely, if ever, seen, and that only after a most complicated process of purification did he obtain gold of a fineness of 999·96. Then again, with the method of assaying by touch-needles. In one respect the Hindoos were more accurate than we are now, inasmuch as they employed seventeen standard test-pieces, distributed over a fineness of from 750 to what was considered to be 1,000, while we divide the whole range from *nil* to purity into only twenty-four parts. Hence their system of *bannees* represented the assays in stages of 15·6 degrees of fineness, whilst our carat system only registers them in stages of 41·6 degrees. But compare this with our present method of the dry assay of gold, which, in the hands of our "skilful serafs," enables them to report their assays with certainty to within 0·1 of a degree of fineness, or one ten-thousandth part.

Apparently the Hindoos used the refined metal for coinage, as no mention is made of alloying it with copper or silver. The coins therefore would contain small quantities only of these two metals. Our own method, of course, is to thoroughly refine the gold, and then to alloy with it a certain amount of copper. The Act of Parliament governing our present gold coinage stipulates that the coins passing out of the Mint for circulation shall assay within + or -2·0 of the standard; that is to say, the gold in them shall not exceed 918·6, nor be less than 914·6; but in practice the coins sent out do not approach even this limit, and the error is invariably less than + or -0·3, or three parts in 10,000. During the phenomenal year of 1889, in the latter part of which the author was temporarily engaged to fill a vacancy as assayer there, no less than 41,096 assays were conducted at the Royal Mint by the small staff in the assay department. This extraordinary number was necessitated by an exceptionally heavy coinage, involving the production of £7,257,455 in sovereigns, and £2,215,742 in silver of various denominations—figures which probably exceed

those which would represent the production by King Akbar during his whole lifetime.

Referring once more to the touch-needles, our present plan is to have two series of test-pieces, in one of which silver is the alloying metal, and in the other, copper, the colour of the streaks in each case of course being widely different. Sometimes a special series is prepared in which both the alloying metals are present, the proportions being adjusted to suit the requirements of the case. The Hindoos alloyed both the metals with the gold in their one set of testing-needles, showing that they were fully acquainted with the existence of copper as well as of silver in their commercial gold.

The other method of assaying mentioned above, of comparing the refined metal with gold of known purity, and weighing one against the other, is a more advanced operation, and is somewhat similar in principle to our present custom of using check assays. In fact a little alteration and development would convert one process into the other.

The modern preparation of the discs for stamping, by rolling and drawing down ingots into plates of definite thickness and punching out the round pieces, is a curious contrast to the above method of casting the metal into round ingots and slicing off the discs. To my mind it is not surprising that in Iran and Turan there was some difficulty in obtaining the pieces of proper thickness. The surprising part is that they could do it with such exactness in Hindustan. But then we are dealing with a history of Hindustan written by a native and a responsible official, whose obvious duty would be to say nothing derogatory of his king and country, but rather to save his head and to court favour by being profuse in his praises. This is borne out by the remarks of the translator, who states that in the original every regulation in the book is prefaced by fulsome and laboured praises of the king. Consequently any statements which appear to be particularly favourable to Hindustan, or disparaging to any other State, must always be considered in conjunction with the fact that there is no evidence of the absolute impartiality of the Oriental writer.

The subject of the mechanical appliances used at various periods and in various places in the preparation of coins has been fully dealt with by Professor Roberts-Austen, in a series of Cantor lectures on "Alloys used for Coinage," delivered before the Society of Arts in 1884. In the first of these he refers to the above-mentioned

old custom of slicing circular ingots to obtain the discs, in connection with King Akbar, and he points out that it is still adopted in the mint at Cabul, which it will be seen was one of the four chief localities for producing the coins of Hindustan in Akbar's time. The following is the passage in these lectures in which the reference occurs:—"It is probable that the use of cast globules was followed by that of cast cylindrical rods of approximately the diameter of the coin; pieces cut transversely from these cylinders would, of course, be circular and could be easily adjusted in weight. There is no reason to believe that this method long survived in the English mints, but it is still practised in India, into which country it was probably introduced previous to the invasion by the Greeks. The beautiful coins of the Emperor Akbar were struck by this method. That it is still retained in India is shown by the following description of the process, as conducted at the Cabul Mint.* 'Silver, refined by cupellation, is melted with an equal amount of English rupees, and the mixture is ladled by hand into moulds, which give it the shape of flattened bars, twelve inches long. These bars are taken to a shed to be annealed, and are, by hammering, given the form of slender round rods. These rods are drawn through a perforated iron plate to give them a uniform circumference, after which they are cut by a chisel into short lengths or slices, of a size requisite to form the future rupee, each of which slices is carefully weighed. Those which are too light have a fragment of metal inserted in a notch, which is then closed up by hammering. The pieces are gently heated and hammered into round blanks, which are pickled in a boiling solution of apricot juice and salt, then struck by a blow of the hammer from engraved dies.' The coins of Edward I. of England were produced by a similar process, but in this case the bars were probably square†, and the square fragments cut off were forged round with the tongs and hammer before being struck. This process was used from time to time in England, up to as late a period as 1561."

The chemistry of the process of refining the gold is instructive. The ignition of saltpetre with brick-dust would produce a reaction between the silica of the latter and the nitrate of potash, yielding nitric acid, or the oxides of nitrogen, which would attack the silver and

* Abridged from an account given in the *Times*, September 10th, 1880.

† Red-book of the Exchequer, quoted by Leake, p. 76.

copper in the gold, forming nitrates of these metals, which in turn would be decomposed again by the heat, and would deposit metallic silver and oxide of copper in the ashes. The reason for employing "new" brick-dust is not quite clear, unless it contains more water than old: the presence of the steam therefrom facilitating the oxides of nitrogen in their action on the silver and copper. At the present time, gold is refined by the aid of nitric acid, or more frequently, on the large scale, by sulphuric acid.

Nitric acid was not unknown to Akbar's people, apparently, as *ressy* is mentioned in the book as "kind of aquafortis, made from soap-ashes and saltpetre earth." They must have used a very peculiar kind of soap in those days.

The methods of refining silver are nearly all based on the principle of melting with lead, and finally cupelling. The utilisation of wood-ashes for the cupels raises a doubt in one's mind; but the statement is a repeated one, and each time the *babool* wood is mentioned as the source of the ashes. This would suggest that there was something in the composition very different from the generality of wood-ashes, which do not answer the requirements of a cupel. On one occasion only is anything approaching bone-ash spoken of in connection with this subject. In this case equal quantities of silver and lead are heated in a "bone crucible," until the "lead is all burnt."

The flame issuing from the purified silver is evidently what is known as the "spit," due to the evolution of dissolved oxygen. It was probably looked upon as a solidified flame. The glow, on solidification, would add to the belief. What is meant by the silver losing "all smell of the lead," by being heated and hammered, it is difficult to say; it may be a mistake in the translation. In reference to what follows—about the easy detection of the metal alloyed with the silver—one can only state that the silver must contain considerable quantities of the metals mentioned to answer to the tests given. Very little is said in respect to the assay of silver. It is stated to have been formerly assayed by the *bunvary*; but this has been discarded in favour of cupellation with lead, which, with very little difference, is identical with our own dry method. It is in connection with this assaying that the bone crucible referred to above is mentioned as being used.

From a consideration of these facts, it is

clear that the ancients were better acquainted with pure silver than with pure gold, not because they knew more about the behaviour of silver generally, nor because they paid less attention to gold than to silver, but simply on account of the processes of refining giving better results in the one case than in the other, owing to the difficulty of removing from gold the last small quantities of the silver with which it is nearly always naturally associated. In support of this statement, evidence is forthcoming in connection with the Table of specific gravities which appears below.

As regards the baser metals, some of the early writers no doubt considered them to be unworthy of much notice. This is evidently the case in the present instance, as one page of the book suffices to dispose of the whole of the remainder of metallurgy. The facts given are all embodied in the above paragraph, under the heading "The Production of Metals," which is almost a verbatim copy of the original.

The metal *rookhtoteea* will be dealt with in the remarks on the specific gravity of metals. The alloy to which the name "white brass" is given, consisting of 80 per cent. of copper and 20 per cent. of tin, is certainly greyish-white in colour on the top edges of a casting, on account of the tendency of the tin to strike to the surface in this alloy, and it is also very nearly white when first cut, but it soon changes in tint, and polishes a light yellow. These properties no doubt have given rise to its name. It is a very hard alloy, but is useless for any practical purposes on account of its brittleness. I have met with examples of it in old Indian brass, but the articles were chiefly ornamental and generally very thick.

The next alloy, *rowee*, is neither useful nor particularly beautiful. It is grey in colour, with a little tinge of pink, but it was evidently not very popular, as there are very few, if any, examples of it to be met with at the present time. The fancy alloys which follow, containing all the then known metals are very dubious mixtures. There is one thing fairly certain about them, and that is, that whatever the proportions of the metals were, the quantities of gold and silver in them must have been very small if there was really any present at all. For the Oriental natives had great ideas of the effect of a little gold in their alloys and were very keen on putting it in morally, but very reluctant in doing so practically. As an instance of this I may mention a case which recently came under my notice.

In the Indian Section of the South Kensington Museum there is a Burmese bell with an elaborate inscription engraved on it describing how it was given as an offering to the seven Precious Things, and how the giver and his sister took their own weight in gold, silver, copper, and other metal, and melted them together. Then in the hot season, at a fortunate hour, he had it moulded and while he wrote the inscription he offered up abundant prayer that no troubles might come nigh him, and that he might attain *Neh'ban*. On analysis, not a trace of gold could be found in the metal, and only a very small quantity of silver, less than one-thousandth part; the alloy simply consisting of a mixture of copper, tin, and lead—in fact, an ordinary bronze rather rich in tin.

The mention of the art of silvering in connection with the alloy *seem suckh'teh*, recalls the old method of coating the baser metals with the more precious ones, by making alloys of the latter with lead, covering the base metal with a thin layer of the alloy, and then firing, to burn out the lead, and thus leaving a thin deposit of the precious metal on the surface of the other. This plan was evidently adopted by the Hindoos, at least the reference to the above alloy would indicate so. Mercury was sometimes used instead of lead, but no mention is made of its employment for this purpose in the present instance.

The composition given for brass is a very poor one, as far as the amount of copper is concerned, and is not in accordance with the bulk of analyses of Oriental brass of this period. The last alloy, *cowelputter*, is certainly a good metal, and is much used at the present day for industrial purposes. It consists of copper and tin, in those proportions which produce the maximum hardness and tenacity of all the copper-tin alloys. It is extremely hard, and bears friction well, and, until recently, was largely used for the journal-boxes of locomotive driving axles, cranes, &c. Ancient bronze swords have been found having this composition; and there is no doubt that it was known long before Akbar's time.

THE SPECIFIC GRAVITIES OF METALS.

"All metals are compounded of vapour and exhalations, which are formed of the four elements; consequently, that mixture wherein there are abundance of fire and air will be comparatively lighter than those which

abound with watery and earthly particles. So that cubes of equal sizes of each kind of metal will differ from one another in weight in the following degrees:—

Gold	100	Iron.....	40
Quicksilver..	71	Copper	45
Lead	59	Brass	45
Tin	38	Rowee	} 46
Silver	54	Sefaid ru ..	

And this is called the specific difference."

"Some calculate with water after the following manner:—They fill a vessel with water, and put into it, separately, 100 miskals of each kind of metal; and, from the quantities of water thrown out upon the introduction of the metals, are found the specific difference between them. That metal which retains the largest quantity of water in the vessel is the heaviest; and, on the contrary, that which ejects the greatest quantity is the lightest. Thus, the ejected water of the before-mentioned silver will be nine miskals and three-quarters, and the gold will throw out five miskals and a quarter. And, when the quantity of water ejected is subtracted from the weight of the metal in air, the remainder is the hydrostatic weight."

"If the water ejected be less than the weight of the body immersed, that body will sink in water; and, if the water exceeds the body in weight, it will float on its surface; but, if the water and the body are of equal weights, it will sink till its surface comes even with that of the water."

After these statements follow three Tables of figures, which were obtained by Abu Rihan Al Birouni, a famous astronomer, who lived during the end of the 10th and the beginning of the 11th century, and who travelled much in India. These figures are the results of experiments undertaken in connection with the subject of specific gravity. They represent, in Table 1, the quantity of water ejected upon the introduction of 100 miskals of the metals (Series I.); in Table 2, the weight in water of the metals when they weigh 100 miskals in air (Series II.); and, in Table 3, the weight of the metals in air when they equal in bulk 100 miskals of gold (Series III.). The results are given in native weights, and from them I have calculated the actual specific gravity as understood by us at the present day, and have placed the results in the following three columns, together with a list of the modern figures:—

TABLE OF SPECIFIC GRAVITIES.
(Calculated from data in "Aycen Akbery.")

	Series I. (from results in Table 1).	Series II. (from results in Table 2).	Series III. (from results in Table 3).	Modern.
Gold	19·04	23·53	(19·04)	19·25—19·36
Quicksilver	13·56	15·28	13·55	13·56—13·59
Lead	10·91	11·76	11·31	11·35—11·44
Silver	10·30	10·52	10·60	10·50
Sefaid ru.	8·57	9·09	8·88	(8·58)
Copper	8·45	8·69	8·72	8·91—8·95
Brass	8·33	8·82	8·86	(8·11)
Iron	7·74	8·63	8·68	7·60—7·88
Tin	7·14	7·50	7·31	7·29

It will be noticed that Series 2 is the outcome of the actual determination of the hydrostatic weight previously mentioned, the ascertainment of which is generally the object aimed at in modern determinations of the specific gravity of compact solids. The weights in Table 3 are comparisons with the gold of the period. In working out the results, therefore, I have taken the specific gravity of gold as 19·04, the figure obtained from actual data in connection with that metal.

The weight of one miskal is equal to that of 96 barleycorns. Now, by experiment, 96 barleycorns in England have been found to weigh about 64 grains, so that a hundred miskals would correspond to a little over 13 troy ounces. This weight, of course, might differ very considerably from the amount of material actually used by the early experimenters, because of the irregularity in weight of seeds of different climates, but it acts as a guide in pointing out that a large quantity of material must have been taken for the experiments. It must be remembered that the balance, as we know it, is a production of very recent date, and that there is a wide difference between the operation of weighing now and in the 11th century; so that the want of extreme accuracy had to be counteracted by the use of large quantities.

Looking over the figures and remembering the period at which the data were obtained, it is simply astonishing how very close they are in some instances to the modern figures. On the whole, perhaps, preference is to be given to the figures of Series 1, which again is still further to be wondered at, since they are the

result of weighing small quantities of water ejected from some kind of vessel.

The original weights given in each Table are undoubtedly the results of actual experiment, and those in one Table have not been calculated from those in another, otherwise the resulting figures given above would obviously be identical in each column.

Examining the figures more closely, the result 19·04 for gold is what one would expect, considering the crude method which then existed for purifying it from the silver and copper with which it is naturally contaminated. It must be remembered that these specific gravity experiments date from a much earlier period than that in which the above description of refinery was written, although probably the process underwent little change in the meantime. Amongst a number of analyses of authentic samples of ancient Indian gold which I have recently made, the percentage of gold is generally less than 98, and is frequently below 95, the remainder consisting of varying ratios of silver and copper, the former as a rule largely predominating over the latter. In only one case did I meet with pure gold, a coin of the 16th century, and that specimen had a specific gravity of 19·26. About 2 per cent. of silver or copper would be sufficient to reduce this figure to 19·04. It is difficult to account for the figure 23·53 in the second column, which is evidently quite wrong. All the results, with one exception, are higher in Series 2 than in Series 1, and this would seem to indicate a difficulty experienced by the ancients in weighing a substance in water. Insufficient submergence would give high re-

sults, and the idea suggests itself that in these old experiments it was deemed sufficient to sink the material to only just beneath the surface of the water. The difficulty in doing this with a substance suspended from a moving scale-beam, would not facilitate the accurate adjustment of the counterbalancing weight, especially with crude apparatus, and this would be quite sufficient to account for the irregularity in the difference between the high results in Series 2 and the lower but more accurate results of Series 1. It, however, would not account for the wide variance in the case of gold, and the only conclusion in regard to the figure 23.53 is that the experiment was very inaccurately performed. There is of course the one outlet in juxtaposition to this, that the recorded figure might have suffered from frequent or incorrect reproduction, and it must be mentioned in this direction that throughout the whole of this paper entire faith has been placed on the correctness of the English translation before me.

The high figure, 15.28, for quicksilver is pardonable, considering the difficulty that must have attended the weighing of a quantity of it in water. The other two figures are very good, and show that Abu Rihan was fully acquainted with pure mercury. The same may be said of silver, whose results are the best on the list; and also of tin. It is rather surprising that quicksilver should not have been considered a distinct metal in view of its great weight and its specific difference to silver. The poor results with lead suggest impure specimens of this metal, and the low ones with copper indicate the presence of a considerable amount of dissolved oxide. The high figures for iron are unaccountable. The modern figure, 8.58, for *sefaid ru* is calculated from the composition given above, while that for brass, 8.11, is obtained from the recorded composition of the alloy, viz., copper 2 parts, and *rookhtoteea* $1\frac{1}{2}$ part, taking the latter to be zinc. This is evidently wrong, and supports the belief that zinc had not been isolated as a distinct metal. *Rookhtoteea* is supposed to have been a kind of native pewter. Pewter is an alloy of lead and tin, but the specific gravity of the above composition, taking *rookhtoteea* to mean English pewter, would be much higher than 8.33. This, then, would tend to show that the native pewter contained much zinc, and that the remainder consisted of lead and tin. It could not be a mixture of zinc and tin only, as the calculated specific gravity of the brass would fall below 8.33. Neither could it be composed

simply of zinc and lead, as these two metals will not alloy. Consequently, *rookhtoteea*, one of the seven metals of the early Indians, was probably an alloy of zinc, tin, and lead. This conclusion is fully substantiated by my own analyses of an extended series of old Oriental brasses, which will shortly appear as a Government report, and which invariably contained considerable, but indiscriminate, quantities of tin and lead, as well as the primary metals for brass—copper and zinc—although, it must be admitted, that the percentage of copper in these old brasses was rarely as low as that corresponding to the above recorded composition of brass, viz., 57 per cent. Oriental alloys, especially the old ones, are very indiscriminate mixtures; and this would account for the variation in the figures relating to *sefaid ru* and brass in the above Table.

THE COINS.

In the beginning of the reign of king Akbar, gold was coined in many parts of his kingdom; but, later on, no gold coins were permitted to be struck, except at the four following places, viz.:—The capital Agra, Bengal, Ahmedabad, and Cabul. Silver and copper, besides being coined at these places, were also struck in ten other cities; and copper coins only were allowed to be made in 28 other places. A large traffic was carried on in mohurs, rupees, and dams. The ordinary round mohur was equal in value, when of full weight, to 360 dams. Now the dam has been calculated to equal about 0.575 of an English penny, consequently, the mohur would be equivalent to about 17s., rather a low value compared to the present mohur, which is equal to nearly twice that amount.

"If, after a time, there was worn away the weight of three grains of rice, they still accounted it of the first degree, and made no difference between them; what was deficient, from four to six of such grains, they made of the second degree, and its value was 355 dams; and, if from six to nine grains were lost, it was then reckoned of the third degree, and its value was 350 dams; and whatever was of shorter weight than the latter was received as bullion."

The rupee was made of pure silver. There were two kinds, viz., the square and the round. The former was equal in value to 40 dams, and the latter to 39 dams. When they became deficient in a certain weight they were rated at 38 dams, and below this were received as bullion.

These customs were in vogue when Akbar came to the throne. They were changed somewhat by him, so that the mohur of three grains deficiency, and the rupee of six grains, were considered to be not of full weight. "And this regulation was the only effectual method that could have been taken for shortening the hands of mean, mercenary wretches; because that, if the officers of the mint coined money of such deficiency of weight, or the treasurers reduced the coins of full weight to this quantity of deficiency, there was no remedy: and also shameless thievish people clipt the coin." "By command of his majesty they made grains of agate, which were ordered to be used in weighing;" and it was further ordered that, in receiving coin for the payment of revenue, "whatever was the deficiency in weight or standard should be taken exactly according to the present rate, and no more."

In this branch of the subject are mentioned some of the so-called immortal coins, with the names and relative values of probably all the coins which were then in use, and which number about forty. Amongst the more interesting are the heavy gold ones, which were elaborated with inscriptions, and of which the following is chosen as affording a good example. It is a circular coin, equal in value to 100 round mohurs (probably about £86), and on the border of one side is the following tetrastich:—

"The sun from whom the seven seas obtain pearls.
The black stone from its rays obtains a jewel.
The mine from the correcting influence of its beams
obtains gold.
And that gold is ennobled by the impression of Shah
Akbar."

On the field is:—

"God is greatest—mighty is his glory."

On the border of the reverse is another tetrastich:—

"This coin, which is the garment of hope,
Carries an everlasting impression and immortal name.
Its fortunate front bears this, sufficient for ages,
That the sun has cast a glimpse upon it."

And on the field is written the date of the month and year.

The translator points out that by the sun in the last line is probably meant the king.

There was another coin, named *sehenseh*, similarly inscribed, and equal in value to 100 *laal jilaly*, or square mohurs. As these mohurs were of a value one-third higher than the round variety, the *sehenseh* must have been worth £115. There were also coins made of half this value, a fourth, fifth, eighth, tenth, twentieth, twenty-fifth, and a fiftieth, but very

little trade was supposed to have been done with these, especially the heavier, coins, which were scarce, and used probably more for ornamental purposes. The smallest gold coin struck was the thirty-second part of the *ilahee*, which latter was equal to twelve rupees. It was impressed on each side with a wild rose, and would be nominally equal to about ninepence.

"It is the custom in the mints of the presence that, for one month's continuance, they coin the gold *laal jilaly*, the *dehn* (one-half of a *laal jilaly*), and the *mun* (one-fourth of a *laal jilaly*); but they do not strike any other gold coins without a fresh order every day."

The largest silver coin mentioned is the rupee, and the smallest is one which is the twentieth part of its value. These coins were round, but there was also a series of square coins, identical in weight and value to the rupee and its divisions, which was first prepared during Akbar's reign. The smallest copper coin was an eighth part of a dam, and would be equal, therefore, to about 0·072 of a penny, or a little less than one-third of a farthing. The dam was divided into twenty-five equal parts, called *cheetels*; but, apparently, these values were only used in calculations, and were not represented by any actual coin.

In the Royal Mint report of 1877 there is a print of a gold coin of King Akbar, which is at present in existence at the British Museum.

CONCLUSION.

In reading through the above account, one characteristic of Eastern life will have been noticed, a characteristic which has always existed, and which apparently will for ever continue to exist, viz., dishonesty. It is a peculiar circumstance that, whatever change has taken place in Eastern tribes, either progressive or otherwise, they have always retained a firm hold on the qualification of misappropriation. The Hindoos are as dishonest to-day as ever they were. They know of the existence of this failing, and always have known of it, which is evident by the precautions which were taken to guard against it, and the mention of it in connection with some of the highest officials in the land. It is extremely doubtful whether Akbar ever possessed that *rara-avis*, an honest native, to fill the post of the third officer of his mint, mentioned above. The greed for gold was exceptionally great, and it is only equalled at the present day in other parts by the desire to possess diamonds. It is hardly to be wondered

at when one considers the relatively great value of gold. For instance, a native workman, in some parts of India, receives now in wages only about twopence per day. Imagine the temptation to such a man when anything in the nature of gold passes through his hands to quietly secure a few days' salary. Two or three grains could easily be cut off, with little chance of detection, except by weighing.

The smooth-edged coins offered special facility for clipping, and this custom has not been altogether unknown in England. Milling the coin, of course, was the means adopted for preventing it in western countries; and it has succeeded, but not so with the Oriental, to whom it presents no difficulty. The Chinaman of the present day has a novel method of manipulating the American dollar. He bores a few holes through the body of it, and then fills them up again with a base alloy of the same specific gravity as the coin.

The above-mentioned case of the Burmese bell is an amusing instance of dishonesty. There are two probable explanations of the wide difference between the stated and the actual composition of the metal. The first is that the man who wrote the inscription was not over scrupulous in respect to the truth, and never intended putting any gold or silver into the alloy at all, in which case his chances of "attaining *Neh' ban*" must have been rather remote. The other is that the person he employed to cast the bell appropriated the precious metals and substituted the baser ones for them. Both cases are possible, but the majority of opinions expressed by persons who are acquainted with the natives incline towards the former as being the more likely of the two. Many persons probably have experienced instances which illustrate the latter explanation, but there is one in which Mr. Purdon Clarke was specially interested, which can be suitably related here, as it affords us a modern example of the ever-prevailing tendency. To complete the effect of the Indian village at the recent Indian and Colonial Exhibition at South Kensington, some native workers were specially brought over to illustrate their handicraft. Among these was a clever and notorious metal-worker, to whom Mr. Clarke handed some gold scraps, broken earrings, &c., to be made into an artistic bracelet. The exhibition closed and a crude bangle was returned with regret that the man had not had time to finish it. The article being useless, Mr. Clarke asked me some time afterwards to recover and purify the gold in it for him. I tried to do so but there was none

there. The characteristic native had the gold, and Mr. Clarke had a piece of burnt brass.

There has always existed a great temptation to be dishonest in connection with the art of gold coinage, in all ages and in all countries. The cheaper the labour—and, consequently, the higher the local value of the metal—the greater, of course, will be that temptation. Professor Roberts-Austen deals extensively with this subject in the Cantor Lectures previously mentioned, and shows that dishonesty has been distinctly prevalent in England. Instances are pointed out in which the preparation and the issue of coins have been unfairly manipulated for the benefit of the ruling power. Henry VIII. was particularly happy in this respect, so much so that, in reference to his coins in Smith's "*Coins of the World*," it is stated that "the gold and silver of Henry VIII. were so debased as to render it impossible to learn or estimate their weight, fineness, and value." The issue of inferior coins was continued in the reign of Edward VI.; but, needless to say, it led to financial demoralisation, and the definite standard had to be restored, with a given margin or "remedy" for weight and fineness. A kind of legitimate fraud has since at times been practised, by issuing the coins within the remedy of fineness, but as near the lowest limit as possible, and appropriating the difference between the nominal and actual value as profit.

Professor Roberts-Austen says:—"The law does not appear to have contemplated that the 'remedy' should be systematically made use of as a source of profit, either to the Crown or to the Master of the Mint. It was rather considered to define the limits within which occasional variations of standard weight were unavoidable. . . . With regard to the action of mint masters in this respect, the history of the coinage abundantly proves that they frequently availed themselves of the 'remedies,' viewing them as a legitimate source of profit, or as a means, incidentally provided by their contracts, for reducing the current expenses of working; the best known case being probably that of Lonison, Master of the Mint in the reign of Queen Elizabeth."

When the remedies were wide, large incomes could thus easily be made, and although the scale of limits has been much reduced, there could be a considerable profit made at the present day if the remedy were persistently used for that purpose; thus, in 1889, it would legally have been possible to have made a maximum profit to the State of £15,000 on the

fineness alone of the gold coinage. Fortunately, we have it on the best authority—the chemist of the Mint, Professor Roberts-Austen—that advantage is no longer taken, nor attempted to be taken, in England, of this opportunity of gaining profit at the expense of the integrity of the nation's coins. This is what he says:—"It is certainly not the opinion of Mint officers at the present day that the remedies should be reduced to the lowest possible point, as this would involve the rejection and re-coinage of a large number of pieces before they could be permitted to leave the Mint; but, on the other hand, all agree that a persistent variation, however slight, above or below standard, has never been contemplated by law. The effect of such a mean variation would be remarkable. If, for instance, the Mint were to issue sovereigns which were either persistently too rich or too poor in gold, to the extent actually permitted by law, a loss or profit would accrue of over £2,000 on each million coined, and a persistent variation of only one ten-thousandth part would be equivalent to a profit or loss of £100 a million. In Mint practice, at the present day, even this comparatively small variation should be avoided, and the public trials of the pyx prove that it does not exist."

The trial of the pyx held by the jury of the Goldsmiths' Company, showed that the fineness of the gold coinage for the year ending June 30th, 1889, averaged 916·657, the precise standard being 916·666. When a large number of the year's coins were melted together and cast into an ingot, that ingot assayed 916·70, or only four hundred-thousandths above the prescribed standard. At the same trial the actual weight of the coins proved to be equally satisfactory—the average of the sovereigns tried being 123·231 grains. The standard weight of the sovereign is 123·27447 grains, with a limit of + or - 0·2 of a grain. Such results are remarkable, and they are as creditable to the skill of those engaged in their production as they are honourable to the nation. They cannot be made too widely known or too frequently placed on record.

In connection with this subject it is interesting to note the above extract from "Ayeen Akbery" relating to the mint coining money deficient in weight, and the treasurers reducing the coins of full weight to the maximum quantity of deficiency, showing, as it does, that the Hindoo of the 16th century was as fully alive to taking advantage of a legal opportunity as of an illegal one.

ECONOMIC CONDITION OF VENEZUELA.

The Republic of Venezuela has an area of 632,695 square miles, it being thus three times the size of France and of Germany, five times that of Italy, and, excepting Russia, larger than any of the European nations. Its coast line has an extent of 1,500 miles, indented by five gulfs. The Bulletin of the Bureau of the American Republic states that the territory of the Republic is divided into three belts, viz., the cultivated, the pastoral, and the wooded. In the first there are cultivated coffee, cocoa, sugar, sugar-cane, bananas, cotton, indigo, cocoanuts, Indian corn, and all the products of the torrid zone, and many of those of the temperate zone, such as rice, wheat, barley, &c. The cultivated regions are mostly made up of extensive valleys, surrounded by high mountains and watered by abundant rivers. The pasture lands are vast plains where many kinds of grasses abound, and which are in many places traversed by rivers, some of which are navigable. The wooded belt is situated near the Orinoco, and contains very rich gold mines. Here are produced, without the necessity of cultivation, caoutchouc, the tonka bean, copaiba, and other articles much prized in foreign markets. The great mountain chain of the Andes, which commences to the west of the Straits of Magellan, after skirting the entire Pacific coast of South America, sends out two of its ranges toward's Venezuela, their great altitudes furnishing varied climates. In the 1,500 miles of coast line Venezuela has 50 coves and 32 ports, besides numerous anchorages. Among these ports there are some which it is said could well give anchorage to the combined fleets of Europe. The territory is traversed by 1,059 rivers, the greatest of all being the Orinoco, which is one of the largest in the world. Its length is 1,300 miles, almost entirely navigable; and, in some places, it is 12 miles wide. Its narrowest part is in front of Bolivar city, and it there measures 3,000 feet in width. The Orinoco has many tributaries, rendering navigation to the neighbouring Republic of Colombia easy, and the branch called the Casiquiare unites it with the Negro river, a great tributary of the Amazon; so that, from the mouth of the Orinoco, on the Atlantic, there is established the extensive water communication which crosses Venezuela, Colombia, Ecuador, Bolivia, and Peru, and which goes as far as Brazil. There are only two seasons in Venezuela, summer and winter: the first is dry, and the latter rainy; but the trees retain their verdure and produce the entire year. The climate is varied. Venezuela is one of the richest republics of South America, as regards natural resources and easy means of developing them; for although its territory is crossed by three mountain systems, their configuration presents many practicable means for communication with the plains and valleys. The greatest wealth of Venezuela consists in her agriculture, and coffee and cocoa are her principal products. The value of the annual export of coffee

is estimated at 12,000,000 dollars, and that of cocoa at more than 3,000,000. The breeding of cattle is another source of wealth for Venezuela. There are at present in the country 11,000,000 head of cattle. The exportation of hides amounts to 1,200,000 dollars a year. The population of Venezuela is about 2,500,000, of whom 326,000 are native Indians. The country abounds in mines of gold, silver, copper, iron, lead, quicksilver, coal, petroleum, asphalt, kaolin, and several other minerals, all more or less undeveloped. There are only in actual operation some gold mines in Guiana belonging to native and foreign companies; those of copper in Tucacas, the coal mines of Naricual, and the copper mines of Carupano. The gold mines of Urunary, in Guiana, are considered among the richest in the world. It may be said that their working is just beginning, and yet their annual output amounts to 11,000,000 dollars. There are several railway lines already completed, and others are being actively constructed by English, American, and German companies. Among these are the Central Railway, which will unite Caracas with the capital of the State of Carabobo, and will be 240 kilometres in length (kilometre = $\frac{1}{621}$ of a mile), and the great Venezuelan railway (*Gran Ferrocarril de Venezuela*), also 240 kilometres in length, starting from Caracas, with its terminus in the city of San Carlos, on the plains of the Republic. Venezuela has good telegraph and telephone service, and is connected by cable with Europe and the United States. As regards her trade, Venezuela is one of the South American Republics which have largely increased their commerce with the United States in the last decade. In 1880 Venezuela exported her products to the United States to the amount of 6,000,000 dollars, and imported merchandise to the value of over 2,000,000. In 1889 her exports to the United States amounted to more than 10,000,000 dollars, and she bought, in the same period, merchandise valued at 5,000,000, which is more than she annually sells to, and buys from, England, Germany, France, and other nations of Europe.

WOOL PRODUCTION IN ASIATIC TURKEY.

The whole of Asiatic Turkey may be considered as a wool-growing country, as according to the United States Consul at Constantinople, every province of Asia Minor produces this article to a great extent. The quantity produced in every district appears to depend largely upon the habits, character, and civilisation of the inhabitants of the respective provinces. Thus the greatest exports of wool, according to the official statistics, are made from Mesopotamia, where the inhabitants are all nomads, and have no other occupation than taking care of very numerous flocks of sheep, and migrating during the whole year from one region to another, according to the climate and foraging conditions of the country. Flocks of sheep are not as numerous in western and

northern Asia Minor as in the valleys of the Euphrates and Tigris. This is due to the fact that in those parts of Anatolia the inhabitants are much more occupied in cultivating the country than travelling all the year round with their tents and flocks of sheep. A relatively higher degree of civilisation, and less nomad life prevail among the people of Anatolia than those of the desert region of Mesopotamia. Another important point which is worth noticing in Asia Minor is that the quality of the wool in each district seems to be influenced by the climatic and topographical condition of the country. Thus the wool of the flocks of sheep of the plains of Mesopotamia, which belong to the Arabs (these people inhabit the whole of the valley of the southern Tigris, and are divided into *achirets*, or tribes, to whom belong the flocks of sheep), and which pass the winter outside, owing to the mild climate of the country, is of much finer and cleaner quality than the wools of the flocks of the north, viz., of the province of Koordistan, where the severe winter obliges shepherds to keep their sheep under peculiar roofs, which are called *aghel* in Turkish, and are always inadequate to cover the numerous animals, which very often lie in dirt, and thus the wool is deteriorated to a great extent. Comparing the different samples of wool, it is found that it is cleaner wherever there are several small rivers which the animals cross. Wool is free from dust when the flocks live in mountainous regions. There is, for example, a far greater amount of dust in the goats' wool coming from the plains lying east of Konieh or Iconium than in that coming from Angora and other regions, which are mountainous. With regard to the different families in Asia Minor, it must be pointed out that there are actually very few differences among the races of various districts, and these differences can be divided principally into two classes. First, the flocks of Anatolia (excluding Mesopotamia), belong generally to the family known in Asia Minor as *caraman*. It is said to be difficult to explain why this name has been given to the principal family of sheep in Asia Minor. One reason that is given is, that it is so called because the district of Caramania and the fields of Tchoukourova (low land)—which are extending to the south—are the places where a great many shepherds meet, coming with flocks from all parts of Anatolia every spring, in order to shear the wool. Secondly, the other principal family is that of Mesopotamia; but the sheep belonging to the same differ essentially, according to the different regions, and no general name is given to it. *Karadi*, or *karakash*, *awassi*, *mendelli*, *kerkouk*, *djaff* are the names given to the different qualities of wool produced in Mesopotamia. The flocks in Mesopotamia have been crossed with Persian sheep, of which they maintain the principal element in their blood. It is reported that 35,000 bales of wool are exported annually from the whole district of Mesopotamia, and the largest proportion of this quantity goes to the United States.

Journal of the Society of Arts.

No. 2,023. VOL. XXXIX.

FRIDAY, AUGUST 28, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a Prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual National Competition held in 1892.

The prize is offered for the best original design for architectural decoration, by means of painting, stucco, carving, mosaic, or any other method, such as that for the side of a room or hall, a ceiling, or the apse or side of the chancel of a church. The design must be on imperial sheets, and must be accompanied by drawings of details on separate imperial sheets. Mere patterns or pieces of painting and modelling, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The work is to be that of the previous school year.

The designs are to be submitted in the usual manner to the Examiners, at the Annual Competition (April, 1892) of the Department of Science and Art. Competing designs must be marked, "In competition for the Stock Prize," in addition to being labelled and staged according to the regulations of the Department of Science and Art.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a prize for £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competitions held in 1892 and in 1893.

The prize is offered to the student who obtains the highest marks in the following stages of instruction :—

A finished drawing of imperial size from the nude living model.

Time studies from the nude living model.

Studies of hand and feet from the living model.

Also, in the 3rd Grade Examination, May, 1892, in drawing from the living model.

No student will be eligible for the award who has not taken a First-class at the Third Grade Examination, and who has not received marks for a drawing of imperial size. Neither of the other two subjects is obligatory, but a fair proportion of marks will be given for each.

The works must be those of the previous school year.

The drawings, &c., are to be submitted in the usual manner to the Examiners, at the Annual Competition (April, 1892) of the Department of Science and Art. Competing drawings, &c., must be marked, "In Competition for the Mulready Prize," in addition to being labelled and staged according to the regulations of the Department of Science and Art.

Chicago Exhibition, 1893.

Forms of application for space, and prospectuses with detailed information, will not be issued till October, but, in the meantime, intending exhibitors can apply to the Secretary of the Society of Arts, and their names will be noted at once, with a view to their receiving early copies of the prospectus when ready.

Proceedings of the Society.

CANTOR LECTURES.

PHOTOGRAPHIC CHEMISTRY.

BY PROFESSOR R. MELDOLA, F.R.S.

Lecture I. — Delivered March 9th, 1891.

Apart from the popularity of photography as an inexpensive amusement, enabling the amateur to obtain with comparatively simple appliances permanent records of places visited, or representations, more or less faithful, of the

features of those whose individuality it is wished to bear in remembrance, the subject is becoming of daily increasing importance on account of the numerous applications which photographic processes have found, both in art and in science. For this reason it is desirable that the claims of photography to be considered a distinct branch of applied science or technology should be urged upon all those who are in any way interested in the advancement of technical education. Some progress has already been made in this direction in certain schools and colleges in this country, but when our efforts are compared with the keen appreciation of the subject which is borne witness to by the splendidly equipped photochemical laboratories of the technical high schools of Berlin and Vienna, it will be admitted that in this, as in other departments of chemical technology, we have allowed ourselves to sink into a secondary position. It is certainly remarkable that the land of Fox Talbot and Herschel—the country which has given to the photographic world all the most important processes discovered since the foundation of the art by Niepce and Daguerre*—should nowhere possess a school of photochemistry where the subject can be taught from a scientific platform, or where original investigators can find the requisite appliances and the skilled assistance necessary for the prosecution of research.

Setting out from the admission that photography must, sooner or later, become incorporated in all schemes of systematic instruction in applied science, I propose in the present course of lectures to show how this subject may be dealt with from a chemical point of view. From this it must not be inferred that photography is to be regarded purely as a branch of chemical technology, for it has also its physical side, and the highly trained photographer should be well grounded in the theory and construction of lenses, spectrum analysis, and, in short, in the general principles of optics. Assuming this knowledge to have been acquired, we may proceed to ask how the subject is to be taught, and the considera-

tion of this question is of considerable importance—it is, in fact, of far greater importance than may appear at first sight, for photography is most admirably adapted to bring out into prominence the principles of technical instruction in a subject which is very largely of a chemical nature. The consideration of this question may help to dispel some of the haze with which the much-abused term “technical training” has been surrounded, and it will certainly lead to a clear conception of the object and scope of these lectures.

There are many who identify technical instruction with the teaching of some handicraft, a notion which has no doubt arisen from the identification of technical skill with manual dexterity in some mechanical industry. By the adoption, either tacitly or openly, of this narrow definition, the chemical industries have suffered to a very large extent in this country, because their progress is more dependent on a knowledge of scientific principles, and much less dependent on manual dexterity than any of the other subjects dealt with in schemes of technical instruction. Now in order to give technical instruction in a subject like photography, which is so intimately connected with chemistry, we may adopt one of two courses. The student may become a practical photographer in the first place, and may then be led on to the science of his practice by an appeal to the purely chemical principles brought into operation. This may be called the analytical method. The other method is to give the student a training in general chemistry first, and then to specialise his knowledge in the direction of photography. This may be regarded as a synthetical method.

In other departments of technology, and especially in those where the underlying principles are of a mechanical nature, the analytical method may be, and has been, adopted with success. It is possible to lead an intelligent mechanic from his every-day occupations to a knowledge of the higher principles of mechanical science by making use of his experience of phenomena which are constantly coming under his notice. From this it is sometimes argued by those who are in the habit of regarding technical instruction from its purely analytical side, that technical chemistry can be taught by the same method. Some teachers may possibly succeed in this process, but my own experience, both as a technologist and a teacher, has led me to the conclusion that, for chemical subjects, the analytical method is both too cumbersome and circuitous

* This is no vain boast. Taking the discoveries in order, we have the silver print and chromatised gelatine emanating from Fox Talbot; the cyanotype due to Sir John Herschel; the collodion process introduced by Scott Archer and Fry; collodion dry plates by Russell; printing with pigmented gelatine worked out by Swan; gelatino-bromide emulsion introduced by Maddox; and the platinotype process of Willis; to say nothing of the photo-mechanical printing processes, such as Woodburytype, to which English investigators have contributed so largely.

to be of any real practical use. No person engaged in chemical industry in any capacity—whether workman, foreman, manager, or proprietor—can be taught the principles of chemical science out of his own industry, unless he has some considerable knowledge of general principles to start with. No person who is not grounded in such broad principles can properly appreciate the explanation of the phenomena with which his daily experience brings him into contact, and if his previous training is insufficient to enable him to understand the nature of the changes which occur in the course of his operations, he cannot derive any advantage from technical instruction. These remarks will, I hope, serve to emphasise a distinction which exists between technical chemistry and other technical subjects, and I have thought it desirable to avail myself of the present opportunity of calling particular attention to this point, because it is one which is generally ignored in all discussions on technical education.

The reason for this difference in the mode of treatment of chemical subjects is not difficult to find. The chemical technologist—the man who is engaged in the manufacture of useful products out of certain raw materials—is, so far as the purely scientific principles are concerned, already at a very advanced stage, although he may not realise this to be the case. The chemistry of manufacturing operations, even when these are of an apparently simple kind, is of a very high order of complexity. There are many branches of chemical industry in which the nature of the chemical changes undergone by the materials is very imperfectly understood; there is no branch of chemical industry of which the pure science can be said to be thoroughly known. For these reasons I believe that I am justified in stating that the chemical technologist is working at a high level, so far as the science of his subject is concerned, and this explains why he cannot be dealt with by the analytical method.

The general considerations which have been offered, apply to the special subject of photography with full force. A person may become an adept as an operator without knowing anything of physics or chemistry; there are thousands of photographers all over the country, who can manipulate a camera and develop and print pictures with admirable dexterity, who are in this position. If we adopt the narrow definition of technical instruction, we should appoint such experts in

our colleges, and through them impart the art of taking pictures to thousands of others. But would our position as a photographing nation be improved by this process? I venture to think not. We might be carrying out the ideas of certain technical educators by adopting this method, but I do not imagine that in the long run the subject itself would be much advanced; our position in the scale of industry would not be materially raised by the wholesale manufacture of skilful operators. And so with all other branches of applied chemistry; it is technologists whose knowledge is based on a broad foundation that are wanted for the improvement of our industries. These are the men which are raised in the technical high schools of the Continent, and whose training the continental industries have had the wisdom to avail themselves of.

To become a photographic technologist, as distinguished from a photographer, it is desirable, therefore, that the student should have received instruction in the general elementary principles of physics and inorganic and organic chemistry. When thus prepared, he may begin to specialise his studies, and the real technical training will be commenced. The application of chemistry to photography will naturally divide itself into two branches: the chemistry of the materials used in the art, and the theory of the chemical changes occurring in photographic processes. This last part of the subject I have already attempted to deal with, to some extent, elsewhere.* With respect to the chemistry of photographic materials, time will not admit of any attempt to draw up a complete code of instruction. Nor is this necessary on the present occasion, for the requirements will be met by the simple statement that this branch of the subject should be an extension of the ordinary chemical training, with special reference to the preparation, properties, and reactions of the compounds which the student is most likely to have to deal with in photography.

In so far as the study of the chemistry of photographic materials is ordinary text-book knowledge, it is not proposed, therefore, to take up your time by unnecessary recapitulation; but certain special reactions, having a direct bearing on photographic processes, may be worth dwelling upon. Since the compounds of silver are by far the most important of photographic chemicals, it will be advisable to commence with these. After a study of the ordinary qualitative reactions of this metal,

* "The Chemistry of Photography," Macmillan, 1889.

the student should be well practised in the quantitative estimation, both gravimetrically and volumetrically, so that the value of commercial silver nitrate may be ascertained with precision. The reducing action of fused sodium carbonate, of zinc and acid, and of alkaline solutions of glucoses on the silver haloids, can be made the basis of practical exercises in the recovery of silver from residues. It is desirable also to point out, and to illustrate by experiment, that silver is displaced from the solution of its salts by the more electro-positive elements—hydrogen, copper, mercury, iron, zinc, lead, and so forth. It is important also to demonstrate that silver is more electro-positive than gold and platinum, and displaces these metals from solutions of their salts.

In illustrating such points in the chemical history of silver as those referred to, and, in fact, in all practical work leading from ordinary chemistry to photographic chemistry, it will be found advantageous to adopt the general principle of performing the experiments, whenever practicable, both in glass vessels and on films. This method is admirably adapted to lead the student from the general science to its special application to his subject. For example, having shown that the salts of silver are reduced by such reducing agents as alkaline pyrogallol, ferrous sulphate, &c., in test-tubes, and having allowed the experimenter to convince himself that the precipitate in these cases is really metallic silver, the production of a film of the metal may be shown by taking a sheet of paper coated with silver nitrate, and, when dry, painting stripes of ferrous sulphate solution on the coated surface. On washing out the excess of nitrate from the unreduced portions, it will then be realised that the dark stripes consist of finely-divided silver on a paper surface. With these silver films many instructive demonstrations can be given. Thus, the fact that silver displaces gold and platinum from solutions of the salts of these metals may be shown by passing the paper through a bath of platinic or auric chloride, when the silver stripe undergoes a change of colour, indicating the replacement of that metal by gold or platinum. A comparison of the strip thus treated with a portion of the original strip—by treating both with nitric acid—clearly proves that the platinised stripe has lost its solubility in that acid. The application of this principle to toning and intensification will naturally follow, when photographic processes are being dealt with.

While demonstrating the reducibility of silver salts by such reagents as ferrous salts, &c., it must be strongly urged that reduction of the silver salt is accompanied by a corresponding oxidation of the reducing agent. This fact will be made apparent by the chemical equations; but it is important that the student should verify it experimentally. Many ways of doing this will suggest themselves, but it will be sufficient if I give one appropriate example. Every student may be assumed to be familiar with the different behaviour of ferrous and ferric salts towards potassium ferrocyanide. Now, on adding a solution of ferrous sulphate to a solution of silver nitrate we get a precipitate of silver, indicating the reduction of the silver salt. That a simultaneous oxidation of the ferrous salt takes place is proved by filtering off the silver and adding ferrocyanide to the solution, when Prussian blue is at once formed. An apology is really necessary for detaining you with such a well-known illustration, but the broad principle that chemical reduction is accompanied by a simultaneous oxidation, is so important in photographic chemistry, that the student cannot be too strongly impressed with its generality.

The precipitation of finely-divided silver may be made use of to illustrate some of the more obscure phenomena with which the photographic chemist is frequently confronted. It is desirable to point out that outside the domain of text-book science there is a mass of information concerning the properties of silver which may become of direct importance in connection with photographic processes, and the consideration of which will certainly help to broaden the student's notions of his subject. It may be well at this stage to broach the idea that photographic chemistry, like all other branches of applied chemistry, does not begin and end with a series of reactions which can be written down in the form of equations. This mode of treating the subject may be academic but it is not technical. It is believed by many experimenters that silver is capable of existing in several different conditions of physical aggregation according to the manner in which it is precipitated from its solutions. Thus the deposit obtained by adding ferrous sulphate to a solution of silver nitrate is grey; the product obtained by reducing silver solutions with organic ferrous salts is darker in colour.* It

* Pyrogallol will reduce silver nitrate in neutral or slightly acid solutions. It is not necessary to add alkali to show this reduction; the solution may be distinctly acid with acetic acid.

is possible that the difference of colour in these cases may be due, as suggested, to the differences of molecular aggregation. The rate of reduction may have something to do with it, and the well-known coloured forms of precipitated gold, studied by Faraday, may be referred to in this connection.

But, on the other hand, there is another possibility, which must be borne in mind and well emphasised in dealing with photographic chemistry. I allude to the tendency which silver and its compounds possess, in common with many other metals, of bringing down and retaining traces of foreign substances, in whose presence the metal or its compounds may be precipitated. This kind of combination is not sufficiently recognised by orthodox chemistry, because it does not take place in definite proportions, but there are many branches of applied chemistry where this so-called molecular combination plays a very important part. The practical outcome of these considerations is that the student of photographic chemistry cannot be too early prepared for the occurrence of indefinite combination, and he must not be allowed to suppose that because a distinct formula cannot be ascribed to such compounds that they are outside the pale of chemical science. I have thought it necessary to utter this caution, because in the present state of knowledge we must not commit ourselves to dogmatic assertions about allotropic modifications of silver. It may be that the different colours of reduced silver are due to the retention of "traces" of some foreign substance. The fact that minute traces of impurity produce remarkably great changes in the physical properties of metals is now familiar through the experiments of Roberts-Austen, and we must be prepared for a similar modification in such a physical property as that of colour by the influence of associated "impurity."

In connection with this part of the subject the recent experiments of Carey Lea* demand some notice. By reducing certain organic salts of silver, viz., the citrate and tartrate, with the corresponding ferrous salts, this experimenter professes to have obtained three allotropic modifications of silver. After carefully considering the conditions of formation, and after repeating some of the experiments, I must say that there appears to me to be no sufficient evidence that these coloured forms

consist of the pure metal. On the contrary, all the evidence goes to show that some impurity is present†; the published analyses of the products in no case show a greater percentage than 98.75 per cent. of metal. If an alloy of gold, containing only 0.2 per cent. of lead, differs so completely from pure gold as to be brittle instead of malleable and ductile; if the colours of many metals can be completely modified by being alloyed with small quantities of other metals, such, *e.g.*, as the deep purple alloy of aluminium of gold, it is not unreasonable to suppose that the colour and other properties of precipitated silver would be modified by combination with 1 per cent. or more of some impurity which may consist of an organic iron salt. At any rate, it seems premature to speak of these products as allotropic forms of silver.

The whole subject of the reduction of silver salts by various inorganic and organic reducing agents is well worthy of engaging the attention of the photographic chemist. Did time permit, I could point out many lines of investigation which might be followed up with comparative simplicity. If the student can be brought to realise that we have yet a great deal to learn about the nature and composition of these coloured products—if the spirit of inquiry can be stirred within him till he is prompted to take up the investigation of some of these compounds for himself—he is far more likely to contribute towards the advancement of photography than by taking any number of pictures. And I will add that if he has the true spirit of technology in his composition, he will derive quite as much pleasure from this kind of work as from manipulating the camera.

The haloid salts of silver will, of course, demand a considerable share of attention from the photographic chemist. The preparation and properties of these compounds should be studied in detail; their solubility in well-known reagents, such as ammonia, potassium cyanide, and sodium thiosulphate, should be made the subject of practical exercises, and the chemical changes undergone can be made readily intelligible to the student whose elementary training has reached the necessary stage of efficiency. It will add to the thoroughness of the instruction if the student is made to realise that the statement that the silver

* "Amer. Journ. Sci. [3], vol. 37, p. 476, and vol. 38, pp. 47 and 129. Also "Phil. Mag.," vol. 31, pp. 238, 320, and 497.

† Thus in repeating these experiments Prange ("Rec. Tran. Chim.," ix., 121) found that the dark substance precipitated from the solution of the so-called "soluble silver" always contained traces of iron as an impurity.

haloid is soluble or insoluble in such or such a reagent is by itself inadequate; he must understand that solubility means the formation of a new compound which is more soluble than the original haloid. Thus the absorption of ammonia by silver chloride can readily be shown by putting some of the dry haloid into a tube, weighing, and then passing dry ammonia gas till there is no further increase in weight. Then, again, silver chloride may be dissolved in strong ammonia, and the solution allowed to stand till the crystals of the ammonio-silver chloride separate. The preparation of the soluble silver sodium thiosulphate, by the method of Lenz,* is a good practical exercise, and the study of this salt will help to make clear why the silver haloids are dissolved by the thiosulphate. It is necessary to point out that by the same reagent three† distinct products may be obtained:—

1. Silver thiosulphate, $\text{Ag}_2\text{S}_2\text{O}_3$, by adding a solution of sodium thiosulphate to a solution of a silver salt, keeping the latter in excess. This is a white insoluble salt, which soon darkens by the formation of the sulphide:—
 $\text{Ag}_2\text{S}_2\text{O}_3 + \text{H}_2\text{O} = \text{Ag}_2\text{S} + \text{H}_2\text{SO}_4$.

2. The insoluble double salt $\text{Ag}_2\text{Na}_2(\text{S}_2\text{O}_3)_2$, formed by adding silver nitrate solution to a

solution of sodium thiosulphate till a permanent precipitate is formed. The product is dark-coloured, and probably contains sulphide; it gradually becomes darker on standing, owing to decomposition with the production of sulphide.

3. The soluble double salt $\text{Ag}_2\text{Na}_4(\text{S}_2\text{O}_3)_3$, formed by the action of excess of sodium thiosulphate upon the last salt, or by adding a silver salt to a strong solution of the thiosulphate, keeping the latter in excess. In the solid condition this is a white crystalline salt, readily soluble in water, and much less prone to decompose into sulphide than the preceding salt.

All this is, of course, only ordinary chemistry, but it must be taught, and cannot be better taught than by letting the student prepare the compounds for himself and study their properties. The utility of this knowledge will become obvious when the fixing process is dealt with.

Among other properties of the silver haloids to which attention may be directed are their decompositions by various haloid acids and salts. This information cannot but be of the greatest use in practical photography. I have summarised the facts in the form of a Table:—

Reagent.	Ag Cl.	Ag Br	Ag I
Cl	No action	Ag Cl formed	Ag Cl formed
Br	" "	No action	Ag Br formed
I	" "	" "	No action
HCl	" "	Ag Cl formed at high temperature	Ag Cl formed at high temperature
HI	Ag I formed	No action	No action
KCl	No action	" "	" "
KBr	Ag Br formed	" "	" "
KI	AgI formed	Ag I formed	" "

"No action" must be taken as meaning no decomposition.

The haloid salts of the alkaline metals and of ammonia, especially when in concentrated solutions, dissolve more or less of the silver haloid, with or without decom-

position. The silver haloid is thrown out again, either in an unaltered state, or transformed into another haloid by decomposition on diluting the solution with water. The solubility of the silver haloids in solutions of other salts is a feature in their chemical his-

* A solution of silver nitrate is added, drop by drop, to a strong solution of sodium thiosulphate till a permanent precipitate (the insoluble double salt) just begins to appear. The solution is filtered and alcohol added till the white crystalline (soluble) double salt separates out.

† There are probably many more double thiosulphates of silver and sodium, and even this series of salts requires further investigation. Thus Mr. C. H. Bothamley informs me

that by mixing 4 AgNO_3 with 5 $\text{Na}_2\text{S}_2\text{O}_3$ and adding alcohol, he obtained a white precipitate in which the ratio Ag : S was 1 : 1.961. The ratio calculated for AgNaS_2O_3 is 1 : 1.683. This salt is soluble and stable. By the action of 3 $\text{Na}_2\text{S}_2\text{O}_3$ on AgBr and fractional crystallisation, he has isolated two crops of crystals corresponding with the formula $\text{Ag}_2\text{S}_2\text{O}_3$, 3 $\text{Na}_2\text{S}_2\text{O}_3 = \text{Ag}_2\text{Na}_4(\text{S}_2\text{O}_3)_4$.

tory which the photographic chemist will find it useful to be put in possession of. Thus these haloids are to some extent soluble, and especially the iodide, in strong solutions of silver nitrate. It must be pointed out that in all cases where a silver haloid is dissolved by another salt, a double salt is probably formed. In fact, many of these double salts have been isolated, and I subjoin a list coupled with the caution that I do not hold myself responsible for the formulæ :—

$\text{AgI}, 2\text{KI}$ and AgI, KI . Bollay, "Ann. Ch. Phys." [2], xxiv, 377.

$\text{AgCl}, \text{NH}_4\text{Cl}$, and AgCl, KCl . Becquerel, Gmelin's Handbook, I, 401.

$\text{AgBr}, \text{AgNO}_3$. Schnauss and Kremer, Jahresb.,

1855, 419; Riche, *ibid.*, 1858, 207; Risse, *ibid.*, 1859, 229.

$\text{AgI}, 2\text{AgNO}_3$. Weltzien, "Ann. Ch. Pharm." xcv, 127; Risse, Jahresb., 1859, 228; Stürenberg, "Arch. Pharm." [2], cxliii, 12.

$\text{AgI}, \text{AgNO}_3$. Schnauss and Kremer, Jahresb., 1855, 429. See also Stürenberg, "Arch. Pharm." [2], cxliii, 12.

$4\text{AgI}, 2\text{Hg}(\text{NO}_3)_2, \text{H}_2\text{O}$. Preuss, Gmelin's Handbook, vi., 199. See also Wackenroder, *ibid.* 159 and 165; Liebig, "Ann. Ch. Pharm.", lxxxi, 128, and Debray, "Compt. Rend.", lxx, 995.

A most useful form of Table, showing the solubility of silver chloride in solutions of other chlorides is given by Hahn in Biedermann's "Chemiker-Kalender," and is here subjoined :—

SOLUBILITY OF SILVER CHLORIDE IN SALT SOLUTIONS, BY H. HAHN.

Salt.	Per centage of Salt.	Temperature of saturation.	Per centage of AgCl .	Per-centage of Ag .	Specific gravity.	Temperature.	Grammes of Ag . per 1,000 c. c.
K Cl	24.95	19.6°	0.0776	0.0584	1.1774	19.6°	0.0688
Na Cl	25.96	19.6°	0.1053	0.0793	1.2053	19.6°	0.0956
NH_4Cl	28.45	24.5°	0.3397	0.2551	1.0835	30.6°	0.2764
Ca Cl_2	41.26	24.5°	0.5713	0.4300	1.4612	30.6°	0.6283
Mg Cl_2	36.35	24.5°	0.5313	0.3999	1.3350	30.6°	0.5339
Ba Cl_2	27.32	24.5°	0.0570	0.0429	1.3017	30.6°	0.0558
Fe Cl_2	30.70	—	0.1686	0.1269	1.4199	20°	0.1802
Fe Cl_3	37.48	—	0.0058	0.0044	1.4172	21.4°	0.0064
Mn Cl_2	43.85	24.5°	0.1996	0.1499	1.4851	30°	0.2226
Zn Cl_2	53.34	—	0.0134	0.0101	1.6005	30°	0.0162
Cu Cl_2	44.48	24.5°	0.0532	0.0399	1.5726	30°	0.0627
Pb Cl_2	0.99	24.5°	0.0000	0.0000	1.0094	30°	0.0000

Similar Tables for silver bromide and iodide would be of special value to photographic chemists.

The study of the forms of reduced silver will have prepared the way for taking into consideration the state of molecular aggregation of a substance as influencing its characters. The silver haloids should be dealt with from this point of view, both on account of the importance of bringing into prominence the factor of physical condition, and because of the possible practical bearing of the subject in connection with the preparation of sensitive emulsions. According to the mode of prepara-

tion of the haloid, such important characters as solubility, reducibility, optical absorption and colour, and photographic sensitiveness are capable of being influenced. Thus, the state of concentration of a solution of silver nitrate, from which the chloride is precipitated by hydrochloric acid, appears to influence the solubility of the chloride in the acid.* It is possible that this is due to the different forms of the chloride under these conditions. By dropping a solution of silver nitrate into strong hydrochloric acid, a considerable quantity of

* Ruyssen and Varenne, "Bull. Soc. Chim." [2] xxxvi, 5. See also Ditte, "Ann. Chim. Phys." [5] xxii, 551.

the chloride is dissolved; according to Pierre,* more than 0.5 per cent. of the weight of acid. The chloride, prepared in the ordinary way, by precipitation from silver nitrate and a soluble chloride, after being washed and dried, is certainly not soluble in hydrochloric acid to the same extent. Here, again, it is possible that precipitation in the presence of strong hydrochloric acid gives no time for the molecular condensation of $(\text{AgCl})_x$ to $(\text{AgCl})_{nx}$, and that the former of these aggregates is more soluble than the latter. The existence of silver chloride and bromide in several modifications was, as is well known, first established by Stas;† but the photographic bearing of the discovery did not become apparent till the general spread of gelatino-bromide emulsion processes led to the further study of these modifications, and especially those of the bromide, by Monckhoven, Eder, Abney, and Vogel.

I have called attention to this feature in the chemical history of the silver haloids, because, in the present condition of practical photography, no student should be allowed to neglect this all-important subject. The information is not to be obtained from the ordinary textbooks used by chemical teachers; and it is instructive to note how a point of comparative insignificance in general chemical training may become exalted into importance as soon as the science becomes to be applied in a special direction. Every branch of technology abounds with illustrations of this principle. How far Stas's classification of the forms of silver bromide and chloride will stand the test of further investigation is at present doubtful.‡ Some experimenters recognise only two modifications, and others three; while Stas himself recognises four, viz. :—

1. Flocculent, white or yellow. Produced by the addition of a solution of a soluble bromide or hydrobromic acid to a solution of silver nitrate in the cold. Both solutions must be dilute (0.5 to 1 per cent.); if the silver is in excess, the bromide is white; if the soluble bromide is in excess, the precipitate is yellow.

2. Pulverulent; obtained from the preceding modification by brisk agitation with water. This form is produced more rapidly in neutral than in alkaline solutions. It is described as

a yellowish-white powder, which, when dry, becomes intensely yellow on heating.

3. Granular; produced by adding a very dilute boiling solution of ammonium bromide to a boiling solution of silver nitrate containing $\frac{1}{10}$ per cent. of this salt. Obtained also by the action of boiling water on the preceding modifications, the first (flocculent) giving a dull yellowish white, and the second (pulverulent) giving a bright, yellowish white powder. By prolonged boiling with water, the granular modification gradually becomes subdivided, and after several days' boiling, forms a kind of milky emulsion, from which the bromide settles out very slowly. The precipitate which then subsides is pearly white, becoming intensely yellow on agitation with a strong solution of ammonium bromide.

4. Crystalline, or fused; obtained by fusing any of the other forms. This modification is never employed in photographic operations.

It might perhaps be suggested that the first form is an unstable hydrate, capable of existing only in the presence of water; but whatever view may be taken with respect to the actual number of modifications, the broad fact that the bromide is capable of forming different molecular aggregates possessing different colours and degrees of solubility may be regarded as highly probable. It is desirable, therefore, that the student of photographic chemistry should at any rate make some experiments in this direction in connection with his laboratory work.

Among other points in the chemical history of the silver haloids which are of photographic importance, the relative reducibility claims special notice. In the earlier part of his practical work, the student will have obtained metallic silver from the haloids by reduction, but he must now be made to realise that this reduction is more readily effected in the case of the chloride than the bromide, and more readily in the case of the latter than with the iodide. And first of all, in order that the true chemical significance of reduction may be made intelligible, let a simple demonstration be given showing that by the action of reducing agents, such as ammonium pyrogallate, potassio-ferrous oxalate, &c., the halogen is actually withdrawn from the silver, and is to be found in the solution by the usual tests. Then, in order to show that the chloride is more reducible than the bromide or iodide, a solution of potassio-ferrous oxalate may be diluted till it becomes just too feeble to reduce the bromide. Some of the same solution will

* "Compt. Rend." lxxiii, 1090.

† "Compt. Rend." lxxiii, 998; "Ann. Chim. Phys." V., 1874; "Chen. Centr.", 1875-81. For thermochemical confirmation, see Berthelot, "Compt. Rend." xciii, 870.

‡ See V. Schumann in *Chem. News*, vol. liii, p. 97.

be found to reduce the chloride readily. Adopting the usual course, and passing from test-tubes to films, sheets of paper coated with the three silver haloids may be streaked with the same solution of ferrous oxalate or ammonium pyrogallate,* when the order of reducibility will be shown by the fact that the chloride gives a darker stripe than the bromide, and the latter a darker stripe than the iodide. The importance of these facts will become obvious when, at a later stage, the subject of photographic development has to be dealt with from its chemical aspect.

Miscellaneous.

SUGAR IN INDIA.

In connection with papers respecting the sugar production of India, printed in the *Journal* last year (vol. xxxviii., p. 495), a communication has been received from the Secretary of State for India, enclosing a memorandum on the cultivation and manufacture of sugar in India by Messrs. Thompson and Mylne, of Beheea, Bengal, suggested by the remarks of Messrs. Travers and Sons, already printed. The following particulars are abstracted from this memorandum:—

There is no doubt that the quality produced per acre in India is much below the average of most other cane-growing countries, and the quality also of the first products is very low; but in making any comparison, and in considering what should be aimed at in endeavours to secure a larger yield per acre, as well as improvement in quality, there are several points of essential importance which need to be kept in view.

The first is that the great bulk of the sugar cane grown in India is not, and cannot be, planted in large blocks or "plantations," by either native or European "planters," under conditions which would render it possible to deal with large quantities of cane or juice at central factories, and profitable for capitalists to invest in the expensive scientific appliances requisite for the "modern processes" which Messrs. Travers refer to.

Nearly the whole of the two and a half or three million acres of sugar cane planted in India is grown by native farmers, who put in a patch of cane in their holdings, of such size as suits them, in rotation with other crops. To ensure success, plans for improving either cultivation or manufacture should be arranged with reference to this important factor.

Another material point is that, in most districts,

* The addition of some sodium sulphite is advisable, in order that the results may not be masked by the too rapid discolouration of the pyrogallate.

each farmer crushes his own cane in the field or village, and converts the juice on the spot into *gur* or *rab*, for which he finds a ready market in the local bazar. In some districts the custom is that several cultivators join in the purchase or hire of a mill, evaporating pan, &c., sharing these and other expenses of crushing and making *gur* or *rab*, but each man arranges independently for the cutting and carrying of his own cane, also for disposing of it as he pleases, just as they do with their other crops.

Another point of importance is that the bulk of the sugar cane now planted in India is grown and manufactured for local consumption, not for export, and the form or character given to it is that which (unless and until the preferences and prejudices of the people can be altered) renders it most readily saleable in the local bazar. There are districts which produce a considerable quantity in excess of what is consumed locally, but the surplus is required for other districts which do not grow sugar at all, or produce less than they consume. Seeing that India now exports to Europe less sugar than was sent out twenty or thirty years ago, many merchants, refiners, and others imagine that less is grown and made in India now than was formerly; but the truth of the matter seems to be that a much larger quantity is now produced than at any time previously, and that it can now be sold in the local bazars at such rates for consumption in India that it would not pay merchants to buy for export. The increase in consumption arises from the improved circumstances of the people, and notwithstanding that much more is produced, a considerable quantity is now imported from Mauritius and other places. One explanation of the increased consumption is that a great deal more is taken by the millions who grow cotton, jute, wheat, oil seeds, and other products, for which outlets have been created by railways and steamers, and for which such large sums have been received by the cultivators; also of the improved means of the large numbers who, during the last thirty years, have found employment in the jute mills and presses, cotton mills and presses, tea gardens, iron works, collieries, railways (construction, maintenance, and working), and other industries which have been established. These have been making much higher wages than the same classes could do previously. In Britain, America, and some other countries, when work is abundant and wages good, the masses consume more largely beef, mutton, tea, and such articles, as well as sugar; but in India it is extra sugar in various forms, both for daily use by the family, and at marriages, festivals, &c., which is chiefly used.

Another point of importance is that the fine white crystallised sugar, with large crystals, so much appreciated in Europe, is not at all in favour with, and is, in fact, avoided by the masses of India, if they see any reason to suspect that bone, charcoal, blood, or any such articles (impure to them) have been used in making it. So strong is this feeling and objection, that dealers frequently find it pays to smash up the

large crystals to a fine powder, which they then sell as native-made Benares *cheenec*.

Another thing to be noted is that (apart from Cossipore, Rosa, Aska, and one or two other places, in all of which exceptional conditions have existed), the profitable carrying on of central factories, by purchasing a sufficient quantity of cane at reasonable rates from those who grow it in their small plots, is not practicable. There are several cogent reasons for this, one being that the rates such factories could pay for cane, which must be carted several miles, would be considerably less than the cultivators would realise by crushing it themselves and making *gur* or *rab* on the spot. Another is that, in most of the cane-growing districts, there are arrangements—customs (established *dustoors*) with regard to crushing the cane, and evaporation of the juice—which entitle the local carpenters, blacksmiths, *kandoos*, and other recognised institutions in each village, to a share of the produce, rendering it difficult for the cane-grower to dispose of his crop in any other than the usual way.

After describing the unwieldy machines formerly in use, Messrs. Thompson and Mylne write:—By novel contrivances and arrangements, a light portable mill was produced, which proved to be so well adapted to the wants, means, and domestic arrangements of cultivators who grow cane in small plots, that it has, in a few years, been adopted in hundreds of districts, not less than 200,000 being now in the hands of the people.

So great an improvement did it prove to be, that, in a village in which the greatest area of cane the cultivators could crush, previously, was about 30 acres, they planted, a very few years after these mills were first placed within their reach, and with them worked off 250 acres, while, last season, they have grown and crushed about 600 acres. The completion of the Sone Canals, and construction of village channels to convey the water to their fields for irrigation, has been another main cause of this large increase, but without the improved mills for crushing, it would not have been possible for these cultivators to have worked off more than 50 acres at the outside.

In the hope of finding a kind of cane which would yield more or richer juice, and at the same time suit the soil and climate, seed cane was obtained from Lower Bengal, North-West Provinces, Penang, Java, Mauritius, and other places. Portions of each were planted in the way usually adopted in Behar, and some according to the methods found most advantageous in Mauritius and other places, several kinds of manure being also used. These trials appear to have started efforts to improve, but it has been found that none of the thick soft kinds would suit in Behar, and those which give the best results are what are locally known as "Mongoo," "Pansaihi," "Barook," and "Bhoorli." The latter is being more largely planted lately, because it stands better than the others in wet soil, of which there has

been a considerable increase in Shahabad since the opening of the Sone canals. Endeavours were next made to effect some improvement in the method of dealing with the juice. Mr. Alfred Tryer, an eminent authority on sugar and sugar refining, has said that "cane juice, from the moment it leaves the cells, should be treated with the same care and cleanliness as is new milk in a well ordered dairy;" but the practice of the cane growers of India and their helpers was, and, for the most part, still is, the exact reverse of this.

The tenants of the Jugdispore estate were urged to exercise more care, the reasons for, and the advantages of doing so being explained to them, and a few of the most enterprising were induced to go so far as to put a strainer over the mouth of the eathern vessel used to catch the juice as it comes from the mill, and so intercept trash, leaves, dust, &c., also to wash out (or rinse) the "receiver" each time it was used, and to fumigate it by inverting it over a pinch of burning sulphur.

The result was that *gur* and *rab* of a much higher quality were obtained; but here came a difficulty, such as in India frequently occurs to hinder improvements. These men, by taking trouble, have obtained a superior article, but found they could get no more per maund or per cwt. for it than could have been obtained if all the dirt had been left in it, and if no care had been taken.

It was not only an article unknown but was suspected, so that efforts had to be made to find purchasers who could appreciate it, and, amongst others, Marwaree dealers, from places 1,000 to 1,500 miles distant, were convinced that as it saved them paying rail freight for those long distances at the rate for sugar on so much trash and dirt, on this ground alone, apart from other advantages, it was well worth their while to give a higher rate for it. The Rosa refinery also, 500 miles away, found that even with rail freight for this distance to be added, they could pay more for this clarified *gur* than they could for the ordinary qualities in districts much nearer Shahjehanpur. A further step was taken to try and devise some simple, inexpensive apparatus and method, by which cultivators of small plots, who crush their own cane, could produce sugar similar in character to that which Messrs. Travers describe as "simply raw sugar properly made by modern processes." In connection with these efforts Messrs. Manlove, Alliott, Tryer, and Co. were consulted, and they, taking much trouble as well as interest in the matter, constructed for the experiment a novel form of Wetzel evaporator, with small steam boiler, fitted with special safety valve and other arrangements to admit of its being used by villagers having little experience in the management of such machinery or processes. They also made for the experiment a specially contrived portable centrifugal or spinner, by which high speed could be obtained with hand power.

Open evaporators, filters, and other appliances,

were made locally, and a second Wetzel was subsequently obtained from Messrs. Manlove and Co. These experiments (commenced in 1873) have been carried on from year to year since, and, at an early stage, proved quite successful as regards the quality of sugar produced; but as no good market could be found for the molasses, of which there was a considerable quantity, the indication for some time was, that the process must involve decided loss, unless a distillery were set up to work off and utilise the molasses. As making spirits was no part of the programme, and as there was no inclination to do this, the project of success seemed far from promising, when it was found that, by carefully evaporating the molasses in the shallow pan used for the first evaporation of the juice in making the *rab*, a very saleable *gur* could be obtained, which, being made from the molasses thrown off by the centrifugal, and strained through grain sugar (itself made from clarified *rab*), was speedily recognised as being specially clean and pure, and so is, from year to year, increasingly appreciated. Thus a way was shown by which the millions of Indian cane-growers may secure greatly improved products and higher returns from their crop without any large, expensive, or complicated machinery, with only a small portable mill to crush their cane, an open shallow evaporating pan, a few *nands* (cheap earthen vessels), in which the *rab* is placed for eight or ten days, to let the crystals form or grow, and a portable centrifugal, any or all of which appliances the cultivators can hire or buy.

It will be seen that the chief aim of these arrangements and experiments has been (1) to secure a better cane crop, and (2) to put the cultivator in the way of getting more sugar from the cane.

Depôts for supplying these machines were opened in various North-Western Provinces districts; and in June, 1888, Mr. J. B. Fuller, then Assistant Director of Agriculture, North-Western Provinces (now Commissioner of Agriculture and Settlements, Central Provinces), wrote regarding results obtained with the new machines, as compared with the *kolhu*:—"If we may apply the result of this experiment to the total production of sugar in these provinces, it follows that, by the substitution of the Beheea mills for the *kolhu* now used, the total annual produce would be increased by the value of nearly a crore and a quarter of rupees," *i.e.*, a million and a quarter sterling. The benefit has been increasing year by year in the North-Western Provinces, as in other parts of India. In the Punjab, also, depôts were opened, and a district committee of leading cultivators reported to the Director of Agriculture (Colonel Wace), after trials made in 1888, that the money gained per season, by using even the smallest size Beheea mill, instead of the "*belua*," was about Rs. 360; and that it gave "other important advantages." Similar results were obtained in the Central Provinces, Madras, Lower Bengal, and other parts of India,

THE FOREST PRODUCTS OF MADAGASCAR.

Among the forest products of Madagascar, caoutchouc is found all over the island, but, says the Chancellor of the French Residency at Antananarivo, in those places which are easy of access, it is beginning to be scarce, and the prices have considerably increased, particularly on the markets of the east coast. On the west coast, where business is less brisk, and where the population is sparser, it is still low priced and abundant. The diminution in the supply is to be attributed, among other causes, to the negligence and indolence of the natives, who, regardless of the future, cut the trees at the foot, in order to more easily arrive at the milk. It is prepared in different ways, and, in those places where there are Europeans, it is possible to obtain it treated with acid, but in many places, either because the cost of sulphuric acid is too great, or on account of the fact that numerous accidents in the manipulation of this substance has rendered it unpopular, tea, salt, absinthe, citric acid, or an extract of tamarinds are substituted. The prices vary according to the locality, and also according to the system adopted and the care taken in its preparation. Caoutchouc enters, to a very great extent, into the exports of the country, and, in order to encourage this industry, the Government ought, in M. Anthouard's opinion, to look carefully after the preservation of the forests, endeavour to prevent fires, and to induce the natives to abandon their habit of cutting down the trees bodily. In these circumstances, Madagascar caoutchouc might realise high prices upon European markets, and successfully compete with the Para product. Gum copal is exported in considerable quantities from the ports on the east coast of Madagascar, and, up to the present, it is only on this coast that the product has been obtained, although there appears to be no reason why the west coast should not furnish its quota. A far more important business might, it is said, be done in this article if greater care were only taken by the natives in its preparation, and if it could be cleansed of its impurities; the quality would then be equal to the Netherlands East Indies. Similar reasons to those which have brought about a reduction in the prices of caoutchouc, have caused a diminution in the volume of business carried on in honey and wax. This product, gathered without any care, and full of foreign substances which have the effect of depreciating it, is nevertheless quoted on the European markets at the same rates as the Senegal product. The natives, to obtain a few pounds of honey or wax, frequently destroy an entire hive, and consequently the swarms of bees are becoming much scarcer. It will be necessary to introduce considerable improvements in the method of gathering this product in Madagascar before any rise in prices can reasonably be hoped for. There is a considerable export of *rafia* fibre from the ports of Tamatave,

Vatomandry, and Majunga. The principal centres of production are on the east coast, between Tamatave and Vatomandry, and in the interior, towards the west of the route, from Antananarivo to Majunga. The exports of this article from the latter district, which, some few years ago, were almost nil, have of recent years largely increased. The principal markets in Europe for rafia fibre are London, Havre, and Marseilles. The fibre is largely used by wine growers in tying up their vines, and it is also employed for many other purposes. Attempts have been made to weave it. Ebony, at one time, was exported in considerable quantities from the north-east coast, but at the present day the trade appears to be entirely confined to the west coast. The forests of Madagascar abound with timber, eminently adapted for building purposes, furniture and cabinet making.

PRODUCTION OF SCAMMONY IN ASIATIC TURKEY.

Scammony, which is obtained from a species of convolvulus or creeper plant, is found in considerable quantities in the environs of Aleppo and other northern towns of Syria. In the month of July or August, says the French Consul at Aleppo, an incision is made into the roots, from which a milky juice exudes, and this is gathered in shells, and emptied from these into large earthenware pots, exposed alternately to the sun and to the wind, with a view to rendering the product dry and saleable. During the operation, foreign substances are frequently found mixed with the juice, and this has the effect of considerably modifying the price. On account of the losses sustained by many purchasers, who have received inferior scammony from the merchants in Syria, very little trade is now carried on in this gum resin with Europe, except under the following conditions:—That the scammony be shipped to Europe at the risk and expense of the consignees, and placed on the markets, with a view to attracting purchasers. The exports of superior scammony effected through the port of Alexandretta, in 1890, amounted to 1,500 kilogrammes (kilogramme = 2·204 lbs. avoirdupois); and the whole of this quantity was consigned to various firms engaged in the drug trade in France, England, Germany, and Italy. The scammony in Italy is forwarded in drums, weighing from 75 to 125 pounds each, and that from Smyrna, in cakes like wax, packed in chests. A considerable trade is also carried on in scammony roots, which are collected in September and October, dried on the spot, and then delivered to the trade. In 1890, the quantity of roots exported from Alexandretta amounted to 175,000 kilogrammes, the half of which was consigned to France, and the remainder to England, in transit for America. Prices have varied during the year between 45 and 50 francs the 100 kilogrammes, free on board.

MANGANESE ORES IN THE UNITED STATES.

The Special Agent of the Division of Mines and Mining of the United States Census-office says that the ores of manganese, or those carrying manganese, may be divided into three general classes. First, manganese ores; second, manganiferous iron ores; and third, argentiferous manganese ores. The dividing line between the first two grades is taken at 70 per cent. binoxide of manganese, equal to 44·25 per cent. metallic manganese, this being the standard of shipments to English chemical works. All ores containing, at least, this amount of manganese, are classed as manganese ores; those containing a less per-centage of manganese, containing also more or less iron, are classed as manganiferous iron ore. In the third class are included the argentiferous manganese ores of Colorado, which are utilised chiefly for the silver they contain. They have an added value, however, by reason of the fluxing qualities imparted to them by the presence of manganese and iron. By far the larger proportion of manganese produced in the United States is mined in three localities—Cremora (Virginia), Cartersville (Georgia), and Batesville (Arkansas). In the year 1889 (the United States census year) 23,927 tons of manganese were produced, of which 20,325 tons were from these three districts. Manganese is found in many places in the United States. For example, all along the western slope of the eastern ridge of the Appalachian range from Maine to Georgia, more or less manganese has been mined. There are also considerable quantities of manganese found associated with the hematite ores of the Lake Superior region, and in Arkansas, south-west from Batesville. With few exceptions, however, the deposits are small, and the indications are not such as to justify the expenditure of large amounts of money in mining and plant, which is usually necessary in the economical production of manganese. In Virginia, along the Shenandoah valley and its southern extension, there are mines at which large quantities of manganese were produced in 1890, and which, it is believed, will add largely to the United States production in the near future. The same may be said of the Georgian mines. As regards manganiferous iron ores, 31,341 tons, containing on an average 9 per cent. of manganese, were produced in Michigan in 1889, and a further product of 50,018 tons of ore, containing 6·74 per cent. of manganese, is exported from the same State, making a total of 81,359 tons of iron ore produced in Michigan, containing sufficient manganese to make it desirable to be mined. The value of this ore is reported at about 19s. a ton. Of manganese-bearing silver ores, 17,550 tons were produced in Colorado. These ores are sold to the smelters for fluxing the siliceous silver ores, and are usually paid for according to the silver contents, that is, so much per ounce of silver without reference to the manganese contained therein.

Journal of the Society of Arts.

NO. 2,024. VOL. XXXIX.

FRIDAY, SEPTEMBER 4, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

The warrant appointing the Council of the Society a Royal Commission for the Chicago Exhibition, 1893, was published in the *London Gazette* of last Friday, August 28th, as follows:—

VICTORIA R.

VICTORIA, by the Grace of God, of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith, to the Presidents, Vice-Presidents, Treasurers, and other Members of the Council for the time being of the Society for the Encouragement of Arts, Manufactures, and Commerce: Greeting!

Whereas it has been notified to Us, through Our Secretary of State for Foreign Affairs, that the President of the United States of America, pursuant to an Act of Congress, has made Proclamation that an Universal Exhibition of the Works of Industry and Agriculture, as well as of the Fine Arts, will be held at Chicago, in the State of Illinois, in the United States of America, in the year one thousand eight hundred and ninety-three, and has invited Great Britain and Her Colonies to take part therein by appointing Representatives thereat, and sending such exhibits as will most fully and fitly illustrate their resources, industries, and progress in civilisation:

And whereas it is Our wish that such Exhibition shall afford full and suitable representations of the Industry, the Agriculture, and the Fine Arts in Our United Kingdom of Great Britain and Ireland, Our Colonies and Dependencies in Europe, Asia, Africa, America, and Australasia, and that Our subjects shall take part in such Exhibition:

Now know ye that We, considering the premises and earnestly desiring to promote the success of the said Exhibition, and reposing great trust and confidence in your fidelity, discretion, and integrity, have authorised and appointed, and by these presents do authorise and appoint, you the President, Vice-

Presidents, Treasurers, and other Members of the Council for the time being of the Society for the Encouragement of Arts, Manufactures, and Commerce, to be our Commissioners to obtain and distribute full information as to the best mode by which the products of the Manufacturing and Agricultural Industries and the Fine Arts of our Kingdom of Great Britain and Ireland, and of Our Colonies and Dependencies, may be procured and forwarded for exhibition; to assist with your advice and co-operation: and generally to promote the success of the said Exhibition.

And Our will and pleasure is that you, the said Council of the Society for the Encouragement of Arts, Manufactures, and Commerce, do report to Us in writing, under the Seal of the Society, all and every the several proceedings of yourselves had by virtue of these presents.

And, lastly, We do by these presents ordain that this Our Commission shall continue in full force and virtue until the close of the said Exhibition, and until the various proceedings in connection therewith shall have been properly concluded and brought to an end; and that you, Our said Commissioners, or any three or more of you, shall and may from time to time, and at any place or places, proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment.

Given at Our Court at Saint James's, the twenty-sixth day of August, one thousand eight hundred and ninety-one, in the fifty-fifth year of Our Reign.

By Her Majesty's command,

HENRY MATTHEWS.

Proceedings of the Society.

CANTOR LECTURES.

PHOTOGRAPHIC CHEMISTRY.

BY PROFESSOR R. MELDOLA, F.R.S.

Lecture II.—Delivered March 16th, 1891.

Continuing the study of those properties of silver salts which are of photographic importance, the next point to be dealt with is the vexed question of the existence of sub-salts. Here, in the present state of knowledge, it is most advisable to avoid dogmatic statements. The utmost that can be done is to summarise the evidence, and to let the student see therefrom that, from a scientific point of view, the existence of such sub-salts has not been conclusively demonstrated. To all who are

familiar with the course of investigation in this direction, it will be evident that the current statements in text-books, and which are repeated in the photographic manuals, must be taught with due caution. I have no time to go over the whole of this familiar ground again, and I must content myself by giving references.* I will only repeat now what I said some years ago, viz., that so far as analogy is to be trusted as a guide, it would seem improbable that the sub-haloid salts of silver should be highly coloured compounds, because the analogous salts of copper, mercury, and thallium are not highly coloured.† Now, all the attempts which have been made to produce sub-haloid salts of silver by partial reduction or by other methods, give rise to coloured products, which have been held by some investigators to consist of the sub-haloids, and by others (Carey Lea) to consist of molecular compounds of the sub-haloids with the haloids proper. It may further be suggested that these coloured compounds might consist of oxyhaloids, mixed or combined (molecularly) with the haloids, that in some cases they might consist of metallic silver or its oxide in molecular combination with the haloid, and that in other cases they might consist of the foregoing compounds or mixtures, or of the true haloids coloured by the retention of a small quantity of some metallic oxide as an impurity.‡

The study of these coloured products is of importance to the photographic chemist, whether they are definite chemical compounds or whether they are molecular compounds, or whatever subsequent research may prove them to be. They are of importance to us here, among other reasons because there may be

some relationship between these compounds and the products formed by the photochemical decomposition of the silver haloids. I have thought it desirable therefore to summarise, in a collected form, the various methods by which these compounds have been produced:—

1. Rose-coloured silver chloride; obtained by reducing a hot solution of silver citrate with hydrogen, exhausting the dark product (before complete reduction) with citric acid, and then treating it with hydrochloric acid. Obtained also by reducing the dry nitrate in hydrogen at 100° C., extracting the product with water and treating the residue with hydrochloric and nitric acids. (Brit. Assoc. Rep., 1859, p. 105.)

2. Chocolate-coloured chloride; obtained by adding a solution of silver arsenite in nitric acid to a strong boiling solution of caustic soda, when "an extremely black powder" is produced. This on treatment with hydrochloric acid becomes grey, and the washed product on boiling with dilute nitric acid loses silver and leaves the chocolate-coloured chloride. (Brit. Assoc. Rep., 1859, p. 106.)

3. Coloured products obtained by acting upon silver with solutions of ferric or cupric chloride have long been known. (Becquerel's films; see G. Staats in Ber. deutsch. chem. Gesell., 1887, p. 2322, and 1888, p. 2199.)*

4. Coloured products obtained by Carey Lea, and described as "photochloride," "photobromide," and "photoiodide" ("photo-salts").

(a.) Purple or black chloride, obtained by the action of alkaline hypochlorites on finely-divided (reduced) silver.

(b.) Red chloride, prepared by adding ferrous sulphate to an ammoniacal solution of silver chloride and then acidifying with dilute sulphuric acid. The precipitate is washed, boiled with dilute nitric acid, washed, and finally boiled with dilute hydrochloric acid.

(c.) Red, or copper-coloured chloride, prepared by heating silver oxide or carbonate to a point short of complete reduction, and then treating the residue with hydrochloric acid.

* The coloured films produced by this method do not always owe their tints to the formation of a coloured product of the nature of a pigmentary colouring matter. The chromatic effect is, in many instances, purely optical, i.e., due to the phenomenon of "thin plates." The coloured spectra recently obtained by M. Lippmann are of the same nature; see Berget's "Photographie des Couleurs," Paris, 1891.

* See "Chemistry of Photography," Lecture I, pp. 39 et seq; also *Nature*, vol. xlii., p. 246 (July 10th, 1890). A brief historical summary will also be found in Carey Lea's paper on the allotropic forms of silver already referred to. Some of the earliest experiments on this subject were made by Wöhler, and will be found referred to, together with much additional work, in a Report published by a Brit. Assoc. Committee, in 1859.

† Thallous iodide is yellow, and mercurous iodide greenish yellow.

‡ Since the delivery of the lecture, M. Güntz has contributed a paper to the "Comptes Rendus" (vol. cxii., p. 861), claiming to have isolated the sub-haloids by preparing, in the first place, the sub-fluoride by the electrolysis of a saturated solution of silver fluoride. By the action of HCl, HI, H₂S, H₂O, &c., on the sub-fluoride, the other sub-haloids, and the sub-oxide, Ag₂O, are said to have been prepared (see *Nature*, April 30th, 1891, p. 620). Seeing the tendency possessed by fluorine compounds to become polymerised, it is, however, by no means certain that the "sub-fluoride," which is described as a crystalline powder resembling bronze filings, has the simple formula Ag₂F.

(d.) By precipitating silver oxide in the presence of the lower oxides of iron, manganese, &c., and treating the product with hydrochloric acid.

(e.) Dark purple chloride, obtained by treating finely-divided (reduced) silver with a solution of ferric-chloride. (Contains 76.07 per cent. of silver.)

(f.) Red chloride, similarly prepared by the action of cupric chloride.

(g.) Red chloride, prepared by pouring dilute solution of silver nitrate on to cuprous chloride, and boiling the black precipitate thus obtained with dilute nitric acid.

(h.) Brownish purple chloride, prepared by pouring an ammoniacal solution of silver nitrate into a strong solution of ferrous chloride, and treating the dark precipitate with dilute sulphuric acid. Becomes lighter with nitric acid. (Similar to b.)

(i.) Purple chloride, prepared by reducing the citrate in a current of hydrogen at 100° C., and treating the product with hydrochloric and nitric acids successively. (Similar to No. 1.)

(j.) Red and purple shades of chloride, obtained by reducing (partially) a silver salt with alkali and an organic reducing agent, such as milk-sugar, dextrine, &c., and then treating with hydrochloric and nitric acids successively.

(k.) Red, brown, or lavender chloride, produced by treating the white chloride with a boiling solution of sodium hypophosphite. The dark, chocolate-coloured product is washed, and boiled with dilute nitric acid.

By somewhat similar methods, coloured forms of the bromide and iodide have been obtained: but it will be unnecessary to trouble you with the details, as these will be found in the original papers. (See "Amer. Journal Sci.," vol. xxxiii., May and June, 1887, and vol. xxxiv., July, 1887.) It is quite easy for the student of photographic chemistry to repeat some of these experiments, and to prepare some of the coloured products. Especially simple are the processes *b, g, h, j*. The repetition of these experiments will not only be useful as practical exercises, but they will serve to enlarge the ideas of the worker with respect to such familiar compounds as the silver haloids, which, in ordinary work, are generally regarded as mere tests for the halogens, and to show him that a wide domain for explora-

tion lies beyond the region of his ordinary chemical experience. In this connection, also, it is desirable to call attention to the tendency of the silver haloids to retain traces of other chlorides, such as those of iron (ferric), cobalt, manganese, nickel, copper, &c.*

From these special studies of the silver compounds we may now pass to another phase of the subject, viz., the combination of silver and its salts with organic compounds. At this stage the technology, *i.e.*, the sources and methods of manufacture of the more important organic compounds used by the photographer may be conveniently introduced. The ordinary organic acids, such as acetic, oxalic, citric, tartaric, &c., will of course have been dealt with in the preliminary training, but in addition to these special attention should be directed to the chemistry and technology of cellulose (including paper, collodion, and celluloid), albumen, and gelatine. Let it be realised in the course of this work that albumen is of the nature of an acid forming salts with various metals. Show the precipitation caused by such salts as those of mercury and silver. Let the precipitated "albuminate" of silver be collected, washed, and dried, and then the presence of silver proved by burning some of the compound, extracting with dilute nitric acid, filtering, and testing in the usual way. The similar tendency of gelatine to combine with silver compounds is very striking, and of fundamental importance to the photographic technologist. The best way of approaching this is to let the student make experiments for himself. A sheet of gelatine can be prepared by coating a glass plate with a warm, strong solution of the substance, and allowing it to dry for some days in a warm place. When stripped off, the film is floated for some hours on a solution of silver nitrate, then removed and washed with water. It now remains to be shown that silver in some form or other has actually been withdrawn from the solution, and has entered into combination with the gelatine. In order to prove this, some of the gelatine compound can be dried, and burnt, and tested, in the same way as the "albuminate." The "gelatino-nitrate" can also be proved to darken on exposure to light. An experiment of this kind will prepare the way for the all-important subject of the preparation of emulsions.

The proportions of materials and the various technical details are fully treated of in all

* Carey Lea, "Amer. Journ. Sci.," vol. xxxiv., p. 384.

works on practical photography, and need no special description in these lectures.* The first point to which attention must be called is the nature of an emulsion, and the influence of the vehicle in keeping the silver haloids in suspension. An easy experiment will bring this home to the student. To a solution of common salt or some soluble bromide add some silver nitrate, and notice the immediate separation of the silver haloid on agitation. Now take some of the same salt solution, add a little strong gelatine solution to it, mix by agitation, and then again add some of the same silver nitrate solution. It will be noticed that the separation of the silver haloid takes place more slowly, and that when formed it does not subside as in the previous experiment, but agitation simply helps to make the contents of the vessel (now an emulsion) more uniform. A similar experiment may be made with ordinary alcohol and ether containing a soluble haloid (ZnBr_2 , or CdBr_2), and then, by way of comparison, with the same alcohol and ether containing dissolved pyroxylin (collodion).

By such experiments as these the principle of emulsification will be clearly brought out. The student should, in connection with these experiments, be well practised in calculating the necessary quantities of the different haloids for precipitating given weights of silver nitrate. At this stage the practical preparation of emulsions might well be commenced, and plates should be coated with gelatino-bromide emulsions, prepared in accordance with any of the adopted formulæ. This should at first be carried out with the object of imparting skill in the *technique* of the operations, the scientific reasons for having an excess of soluble bromide, and for washing out excess of soluble salts being explained in the course of the work. These explanations will of course only be fully appreciated after the action of light upon the silver haloids has been dealt with, and the practice of emulsion making can, if thought desirable, be deferred to a later period.

In the same way that the compounds of silver are prepared and studied, the other photographic materials should be dealt with. Their ordinary chemical properties should be familiar to the student, not only through reading or attending lectures, but by laboratory

work. His knowledge should be as wide as possible, and should embrace the compounds of iron, chromium, manganese, uranium, copper, mercury, platinum—in short, of all the metals having any connection with photography, and, it is hardly necessary to add, that the special uses of any of these compounds in photographic processes should be dwelt upon exhaustively. To this knowledge it is desirable to add an acquaintance with the formulæ and mode of preparation of the reducing agents, both inorganic and organic, used for development, such, *e.g.*, as hydroxylamine, pyrogallol, hydroquinone, eikonogen, and so forth.

Armed with this general chemical knowledge, specialised in the direction of his subject, the student will be in a position to proceed to the particular kinds of decomposition, viz., photochemical, upon which the art of photography is based. This part of the subject must also be dealt with as broadly as possible, for it is of the utmost importance that the principle should be realised that the photochemical decompositions made use of in photography are but particular instances of a general class of such decompositions, some of which are at present not available for photographic purposes. It must be pointed out that a study of some of these collateral decompositions is likely in the future to lead to results of practical value, and may certainly be expected to throw great light on the nature of the photographic image.

The broad distinction between purely physical changes induced by light and actual photochemical decomposition may be maintained, although it is often difficult to refer a particular case to one or the other of these classes. Complete lists of all the known instances of the physical and chemical action of light will be found in the works of Eder and Vogel,* but it is advisable, in treating the subject as a branch of chemical technology, not to bewilder the student, at first, with a vast array of facts, but rather to enforce general principles by a few well-chosen illustrations which the student can work out for himself without much difficulty. The simplest kind of photophysical action is that which produces a change in molecular structure, either temporary or permanent. In connection with this, the action of light upon selenium is perhaps the most striking illustration that can

* Abney's works are of course familiar to all practical photographers in this country. The latest edition of Dr. Eder's "Photographie mit Bromsilber-Gelatine, &c.," will be found invaluable to those who can read German.

* Ausfuhr. Handb., Part I.; Vogel's Handb. d. Photog., Part I.

be given, and where the necessary apparatus is at hand, it would be well to demonstrate the point experimentally in the usual way. As examples of permanent change of molecular structure, the modifications in crystalline form undergone by certain substances on exposure to light may be appealed to and illustrated. The following experiments can be easily done in the laboratory:—

1. A saturated solution of sulphur in carbon disulphide is prepared, and two or three tubes are filled with the solution and sealed up. The contents of a tube kept in the dark will remain clear for an indefinite time, but on exposing one of the tubes to sunlight, the contents become turbid, and a gradual separation of insoluble sulphur crystals will take place.

2. A plate of glass is coated with a silver mirror by any of the usual methods of chemical reduction. The mirror is iodised by exposure to the vapour of iodine,* and then exposed to bright light (electric arc or sunlight) for 10 or 15 minutes, one portion of the film being protected by a dark paper screen. The film is semi-transparent at first, but, after the experiment, it will be found that the exposed portion has become yellower and more opaque than the screened portion, the change being apparently due to a physical modification of the silver iodide.

Such experiments as these will serve to impress the mind with the fact that light can cause purely physical changes. Attention may be called to the existence of other changes of a like nature, such as those which occur in red cinnabar, in red realgar, in the crystalline form of nickel sulphate and zinc selenate, &c. From cases of this kind we are led, in the next place, to other changes, which serve to connect photophysical with photochemical action, viz., photopolymerisation. The meaning of the term polymerisation will be familiar to the chemical student. It must be pointed out that many of the changes in crystalline form, &c., alluded to in connection with the previous examples, may be really cases of photopolymerisation or depolymerisation. Then the known cases of the polymerisation of organic compounds, such as anthracene to paranthracene, styrene to metastyrene, vinyl

bromide, thymoquinone to an insoluble modification,* and so forth, may be dealt with and illustrated, as far as possible, experimentally. Pointing out, by way of caution, that it is often very difficult to discriminate between photopolymerisation and photo-oxidation, the action of light upon asphalt and bituminous substances may be taken as an illustration of the difficulty in question; and a study of the action of light upon such films will naturally lead to the various heliographic processes based upon the original method of the elder Niepce. How far it is desirable to lead the worker in this direction from the practical side must, of course, be determined by circumstances.

The action of light upon asphalt and similar substances is not only of practical importance, but its scientific aspect is worthy of the most serious attention, both by the student and the investigator, who, after all, is himself only a student at a somewhat more advanced stage of his studies. There is some doubt at present whether the insoluble asphalt resulting from the action of light is a polymeride, or whether it is a product of photochemical oxidation. According to some authorities, the change does not take place in a vacuum, neither in nitrogen nor in hydrogen. On the other hand, it is stated by Kayser, in favour of the polymerisation theory, that no increase of weight occurs in the film, that the insoluble asphalt is converted into the soluble form again by fusion, and that a solution of asphalt in a closed vessel also deposits the insoluble modification on exposure to light. The decision of this point rests with future investigators, but certain facts have been discovered with respect to the constituents of asphalt which must be emphasised in connection with photographic chemistry. It has been found that Syrian and Trinidad asphalt contain a small quantity (4 to 5 per cent.) of a substance soluble in alcohol and insensitive to light, another portion (44 to 57 per cent.) soluble in ether, and a residue insoluble in ether, varying from 52 to 38 per cent. The portions soluble in alcohol and ether, and the insoluble residue all contain carbon, hydrogen, and sulphur; and Kayser, who has investigated these compounds, has gone so far as to assign formulæ to them. The portion which is soluble in ether is sensitive to light, but not so sensitive as the insoluble residue, which contains the constituent of the greatest value

* Such films of silver haloids on glass are very convenient for experimental purposes, as they are (when dry) absolutely free from anything that can be regarded as a sensitizer, and are therefore particularly well adapted for purposes where films of the pure haloids are required.

* H. W. Vogel has obtained a positive print in thymoquinone by making use of this property. See his "Handbuch," Part I., p. 41.

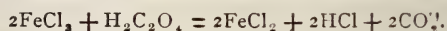
for the heliographic processes. The practical outcome of these investigations has been the preparation of a high quality asphalt, consisting essentially of the portion insoluble in alcohol and ether. It may be added that the property of becoming insoluble in hydrocarbon oils on exposure to light does not appear to depend upon the constituent containing the sulphur, as some specimens of asphalt from different parts of the world, which possess the same property, have been found, on analysis, to be free from sulphur, and to consist of hydrocarbons only.

Before leaving these facts concerning asphalt, I should like to point out that there is a promising line of investigation here, which would well repay a few years' patient work, even if it led to no practical result. I am inclined to believe, however, that the results would be of practical value, and especially in the direction of increasing the sensitiveness of the asphalt film. Asphalt is a complicated mixture of hydrocarbons, &c., and it is probable that the sensitiveness is due to a few or possibly to only one of its constituents. It would be worth while therefore to make a further series of experiments having for their object the isolation of the sensitive constituents. I need hardly pause to point out of what immense value it would be to have a bitumen film possessed of a sensitiveness approximating only to that of the silver bromide emulsion.

From these cases of photophysical action, of polymerisation, and of possible photochemical oxidation, the study of true photochemical decomposition may be taken up. On account of the comparative simplicity of their decomposition, the salts of iron lend themselves admirably for demonstration at this stage. The study of the ordinary chemical reactions of iron salts will have prepared the way. Having shown how reducing agents convert ferric into ferrous salts, let it be demonstrated experimentally that many organic compounds, such as alcohol, oxalic acid, &c., do not immediately reduce ferric salts. It must then be pointed out that these organic compounds are susceptible of oxidation by ferric salts under the influence of light—that they are in fact potential reducing agents. This can be done in test-tubes or flasks in the first place, and then on paper films, leading to the ordinary cyanotype and blue printing processes. A few hints for the carrying out of the experiments may be found serviceable:—

(1.) A solution of ferric chloride (2.3 p.c.),

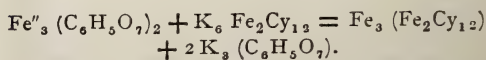
mixed with a solution of oxalic acid* will of course on testing with potassium ferricyanide give no blue colouration. Some of the same solution, exposed for five minutes or so to strong light, will be found to contain ferrous salt, on again testing with ferricyanide:—



2. By using ferricyanide with the ferric salt, and exposing to light, the reduction is made visible by the formation of Turnbull's blue. This can be done by adding ferricyanide to the foregoing, or preparing two solutions: one containing 8 grms. of potassium ferricyanide in 50 c.c. of water, and the other containing 10 grms. of ammonio-ferric citrate in 50 c.c. of water. The solutions are mixed before use, and then exposed to light, first in a test-tube, and then on paper coated with the solution, and allowed to dry in the dark. The practical application of this method for copying and printing will be obvious.

The chief point of general theoretical importance brought out by such experiments as these is, that light only reduces the ferric salts in the presence of oxidizable compounds of sufficient instability. It is advisable, at this stage, to introduce the notion of *sensitizers*, and to point out that oxalic acid, citric acid, alcohol, &c., may be regarded in this light in the experiments referred to. The demonstrations with ferric salts may, of course, be extended in many directions, and made the basis of numerous practical exercises and lessons in the application of general chemical principles to special cases. All that has to be borne in mind is, that a surface of an organic salt exposed to light under a stencilled design (or a picture) gives ferrous salt on the exposed portions, leaving the unexposed portions unchanged. Various reagents may then be used to reveal the chemical difference in the two portions, the subject of photographic development being thus introduced, and the changes involved being explained by ordinary chemistry. By way of example:—

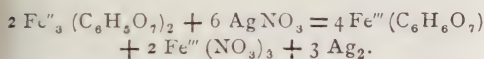
(1.) A design printed on paper coated with ammonio-ferric citrate is developed by ferricyanide. The exposed (reduced) portions come out blue owing to the formation of Turnbull's blue. Supposing ferrous citrate to be formed:—



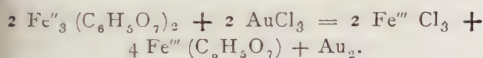
* The addition of some alcohol increases the sensitiveness of the mixture.

The blue design, after being well washed, can be made the subject of many further experiments, all instructive as illustrating chemical principles with which the student should be familiar. Thus, on treatment with a dilute solution of caustic soda, the blue is at once decomposed with the formation of Fe_3O_4 , which remains on the paper. We have thus a faintly visible brownish design, which can again be developed by taking advantage of the property possessed by the oxides of iron of forming coloured compounds with organic substances, such as gallic acid, alizarin, nitrosophenols, &c.

(2.) The design printed on the ferric salt may be developed by taking advantage of the reducing power of the exposed (ferrous) portions and the non-reducing power of the unexposed (ferric) portion. Thus with a solution of silver nitrate :—



With a solution of auric chloride :—



Similarly with platinic chloride, chromates, mercury salts, and other reducible compounds.

(3.) Development can also be effected by utilising the oxidising property of the unexposed (ferric) portion, and the non-oxidising power of the reduced (ferrous) portion, such, *e.g.*, as by immersing in a solution of potassium iodide, mixed with starch paste.

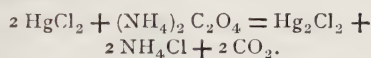
Such demonstrations as these cannot fail to give a vivid idea of the effect of photochemical decomposition, and the striking results that can be obtained by the application of familiar reagents. It may be pointed out that the photochemical reduction of ferric salts, although practically useful for printing purposes, takes place too slowly to enable these compounds to be used at present for the production of camera pictures. But there is no reason why the rate of photochemical reduction—*i.e.* the sensitiveness of these compounds—should not be increased by admixture with some easily oxidisable substance and a sensitive film prepared by this means, which would cheapen photographic processes, by dispensing with the use of silver salts.

In the same way that the photo-chemistry of iron is studied, the other sensitive metallic compounds may be dealt with. The reduction of uranic salts, and the development of uranium prints by various reagents, will naturally be

connected with the analogous ferric salts. The photochemical reduction of chromates in the presence of organic substances, such as gum, albumen, and gelatine, will lead to the numerous practical applications of chromated gelatine in the processes of etching, pigment printing, collotype, &c. In these processes practical instruction may be given at this stage as far as thought desirable. The salts of mercury and copper may also be studied with advantage, as illustrating the nature of photochemical decomposition. The well-known greenish mercurous iodide is easily prepared by decomposing freshly-precipitated and washed mercurous chloride with a solution of potassium iodide. Some of this salt, washed by decantation, and exposed under water to the action of strong light, rapidly darkens, owing to the liberation of metallic mercury. According to H. W. Vogel, the decomposition may be represented by the equation :—



The compound Hg_4I_6 is mercurioso-mercuric iodide, Hg_2I_2 , 2 HgI_2 . The decomposition of mercuric chloride in the presence of ammonium oxalate is also an instructive illustration of photochemical decomposition, as it takes place with comparative rapidity, being the reaction made use of in Eder's chemical photometer :—



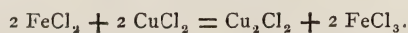
The action of light on the salts of copper forms a convenient introduction to the photochemistry of the silver salts. Thus cuprous chloride darkens, on exposure to light, with as great a rapidity as silver chloride. It may be pointed out that the nature of the decomposition in this case is not completely understood. Wöhler conjectured that the product might be an oxychloride, and this view receives support from the circumstance that cuprous chloride does not darken under hydrocarbon oils or other liquids which do not contain oxygen. A. Vogel assigns a formula CuCl_2 , 3 CuO , but the subject requires further investigation.*

A general discussion of the subject of photochemical decomposition, as illustrated by the foregoing and other examples, will enable the student of photographic chemistry to grasp the broad idea that modern photographic processes represent only the special applications

* See Dingler's "Poly. Journ.," vol. cxxxvi, p. 238; also Carlemann, in "Journ. für Prac. Chem.," vol. lxxii, p. 475.

of wider principles, and that photography with silver compounds may be but a passing phase in the history of the art. In the present state of knowledge, no rigorous classification of the cases of photochemical decomposition is possible, and it is only necessary to point out, and to illustrate by an appeal to some of the many known instances, how difficult it is to draw a hard and fast line between photochemical decomposition and photochemical combination, or between decomposition and dissociation under the influence of light. Many of the supposed cases of dissociation may be dependent on the presence of another substance capable of combining with one or the other of the liberated products, and thus playing the part of a sensitizer in relation to the present subject. From such considerations as these, it will follow that in all modern photographic processes we have to deal with a mixture of chemical compounds capable of passing into a more stable system under the influence of light as a source of external energy. If the new products formed in this way are so acted upon by reagents subsequently applied that a visible and striking colour difference is produced, or if the new product differs in colour from the original substance or mixture of substances, we have all the essentials for a photographic method.

When discussing photochemical decomposition it should be pointed that indirect results are often obtained by using a mixture of substances of which one of the constituents is not directly affected by light, but is altered by contact with the product resulting from the photochemical decomposition of the other constituent of the mixture. For example, paper, coated with ferric chloride, and exposed to light, gives a surface of ferrous chloride by photochemical reduction, the size or cellulose of the paper acting as the sensitizer (chlorine absorbent). But if the surface is coated with a mixture of ferric chloride and cupric chloride, the ferrous chloride which is formed reduces the cupric salt with which it is in contact :—



The picture is thus formed in cuprous chloride instead of in ferrous chloride, and, by treatment with potassium thiocyanate, cuprous thiocyanate is formed which, on subsequent treatment with potassium ferricyanide, leads to the development of a brown print. This

method of utilising a mixture of ferric and cupric salts is the basis of Obernetter's process.

There can be no doubt that this principle of indirect decomposition is destined to play a very important part in the photography of the future. It has already come into prominence in the well-known platinotype process of Willis, in which a surface is coated with a mixture of ferric oxalate and potassium chloroplatinite. On exposure to light ferrous oxalate is formed, while the chloroplatinite is not directly reduced. On treatment with a hot solution of potassium oxalate the ferrous oxalate is dissolved out, and at the moment of solution reduces the chloroplatinite to finely-divided platinum *in situ*. In the direct printing platinotype process we have a surface of potassium chloroplatinite, sodium oxalate, and sodio-ferric oxalate. In this case the reduction of the ferric salt by light is accompanied by the indirect reduction of the chloroplatinite by means of the ferrous salt thus formed. In the cold platinotype of Willis the operations are separated, the ferric surface being first exposed in the usual way, and then development being effected by immersion in a cold solution of potassium chloroplatinite containing potassium oxalate and phosphate.

The discussion and illustration of indirect methods of decomposition, as illustrated by the platinotype processes, may advantageously occupy the student's attention at this stage of his work. The chemistry is comparatively simple, and many experimental illustrations will obviously suggest themselves to the teacher.

Miscellaneous.

THE WORLD'S RAILWAYS.

The *Archiv für Eisenbahnwesen* for 1890, issued by the Department of the Prussian Minister of Public Works, gives some particulars of the development of the various railway systems of the world for the period covered by the years 1884 to 1888. The information contained in this publication is based upon official data; and it appears from it that, during the period above mentioned, the total length of the railways of the world have increased by 63,894 miles; the entire length, at the end of 1887, amounted to 355,070 miles. During the years from

1884 to 1888, America furnished the largest number of new lines, to a length of 40,084 miles (that is, more than half the total increase noted above), of which 30,774 miles were built by the United States. Canada constructed 3,044 miles; the Argentine Republic, 1,965 miles; and Brazil 1,748 miles of new lines. After America, Europe constructed the largest number of new lines in these five years, namely, 15,164 miles. At the head of the constructing countries come France and Germany, and, curiously enough, the number of miles of new lines opened by these two countries is exactly the same, namely, 2,514 miles; Austria follows, with 2,272 miles; Russia, with 2,262 miles; and Italy, with 1,420 miles. The latter country has increased by 23 per cent. the length of its railway system during the past four years under review. The United Kingdom only increased its total length of railways by 984 miles, an increase of 5 per cent. of its system. Spain added to its length of line by 612 miles, or 11 per cent.; Sweden, by 576 miles, or an increase of 14 per cent.; and Roumania, by 542 miles, or 54 per cent. In Belgium, 287 miles of fresh line have been laid; in the Netherlands and Luxemburg, 215 miles; in Greece, 305 miles; in Servia, 175 miles; in Turkey, 158 miles; in Portugal, 240 miles; in Switzerland, 75 miles; and in Denmark, 43 miles. Norway has not added a single mile of line to its railway system. Taking next Asia, British India has contributed the largest proportion to the general increase, namely, 2,986 miles; then come the railways of the Transcaspian territories of the Russian Empire, which have added 746 miles to their railway system, by the construction of the line from Kissil-Arvat to Samarcand. Japan also has contributed to the general increase by an addition of 456 miles of new lines. China and Persia have added nothing. In Africa, Algeria and Tunis come at the head of the movement, with an addition to their systems of 568 miles. Egypt has remained stationary. Australia has taken a prominent part in the augmentation of railways, having added a total length of 2,891 miles, or an increase of 38 per cent., of which 723 miles were constructed in Queensland, 576 miles in New South Wales, 565 miles in South Australia, and 506 miles in Victoria. Taking the proportion of the railway lines to the area of the country, Belgium heads the list with 26.4 miles to every 100 square miles. The proportion of Saxony, the United Kingdom, and Alsace Lorraine varies between 16 and 24 miles to every 100 square miles. The German Empire, in this respect, is not far ahead of France; for, in 1887, the proportion in the former country was 12.2 miles, and in France 10.8 to every 100 square miles. The cost of constructing one mile of railways amounts, in Europe, to an average of £23,848; in non-European countries, the average cost is only about half this amount. It is estimated that, taking the whole of the globe, an amount exceeding £6,220,000,000 sterling has been expended in the construction of railroads.

AGRICULTURAL INDUSTRY IN ASIATIC RUSSIA.

The *Journal de la Chambre de Commerce de Constantinople* says that at a recent congress of Orientalists at Berlin, Dr. Wiedemann read a very interesting paper, having for its subject "The Condition of Asiatic Russia from an agricultural and commercial point of view." It appears, from this paper, that agriculture can only be practised with any degree of success in the centre of Asiatic Russia in those districts where water-springs exist, and the latter are by no means plentiful. The greater part of the country is uncultivated, and, as far as the eye can reach, there are vast expanses of moor-land and steppes. In summer the heat is intolerable, and in winter the cold is most intense. It is only in the south that tracks of fertile land are met with. Among these may be mentioned the oasis of Merv, which has a population of about 100,000. In this part of Asia the climatic variations offer some very curious phenomena. In December and January the cold is intense, in February the temperature rises considerably, and, while in January the thermometer points to 15 degrees (Centigrade) below freezing point, it is not unusual to find, in February, the temperature up to 25 degrees. In May, June, July, August, and September the temperature rises to 52 degrees, and it is only in October and November that a little rain comes to cool the air and reduce the temperature. The question of water is one of the most important in connection with the agricultural industry in this part of the world, and it is for this reason that the Russian Government have for some years past made the greatest efforts to provide for the means of irrigation. The products at present derived from the soil are tobacco, rice, various sorts of vegetables, cotton and cereals. The resources of the inhabitants consist less in land than in sheep and camels, the rearing of these animals costing but little. During recent years the number of camels has considerably decreased, for, at the present time, on the markets where formerly vast numbers were found, there are now seldom any to be seen. The cotton yields three crops a year, but the yield is frequently affected by the rain, which usually comes about the harvest time and turns the seed brown. The greater part of the cotton grown in Asiatic Russia goes to France. The cultivation has been greatly improved by the Russians, and at the present time an acre of land yields about 900 lbs. of cotton. At Tashkend there are establishments where the cotton is cleaned by mechanical process, and Russia alone draws from the cotton-growing districts of Asiatic Russia from 6,000,000 to 7,000,000 pounds (*poud* = 36 lbs. *avoirdupois*) of cotton annually. Among cereals, wheat and barley as articles of export are the most important. The Government, it is said, neglects no opportunity of improving agriculture, and with the object of developing the industry, they have established agricultural schools and dis-

tributed publications dealing with agricultural subjects. The Russian Turcomans own 5,000,000 of goats and sheep, 700,000 horses, and 400,000 camels. Wool and sheepskins represent important articles of commerce, and are frequently found on Russian markets. The most important cotton market is Merv, where the traders assemble outside the town, in the open fields. Merv, however, has lost much of its importance since it ceased to be the terminus of the Transcaucasian Railway. Bokhara, at the season of the bazaars, also becomes an important market, much frequented by traders and Jews, who arrive in great numbers. In conclusion, the *Journal de la Chambre de Commerce* states that the central districts of Russia in Asia are at the present time seriously engaging the attention of the Russian Government, with a view to bringing them under a proper system of cultivation; and the efforts that are being made in this direction on the one hand, and the construction of railways on the other, cannot but produce good results, and furnish Russia with fresh means of promoting her industries and improving her international trade.

RICE CLEANING IN HONG KONG.

The United States Consul at Hong Kong says that all the rice received there is unclean, with the exception of that brought from China, the average of paddy being about 20 per cent. It is prepared for market at Hong Kong, with the exception of that shipped to Canton, which, owing to the cheapness of labour in comparison with Hong Kong, is cleaned there. The process of cleaning is slow, and the labour most harassing. It is first run through hand sieves to separate the paddy from the grain. The paddy is first run through a machine made of wood, shaped not unlike a set of millstones, both sawn from a log about three feet in diameter. Into the face of the under block, and flush with it, is let a circular stone of a diameter to leave a five-inch rim of wood. This stone is opposed to an opening or eye in the upper block of a like diameter, into which is fitted a perforated board. The opposing surfaces of the two blocks are cut into grooves three-eighths of an inch wide, one-fourth of an inch in depth, and about the same distance apart, the intervening ridges of wood being carefully trimmed about every three hours, in order to be kept sufficiently sharp. The upper block is dragged round by means of a hook at the end of a wooden handle fastened to a staple driven into the rim, a single workman turning it and, at the same, feeding the machine by throwing the paddy with a wooden paddle into the eye, from which it is distributed outward by the centrifugal force. This breaks and loosens the husk from the kernel, after which it is run through a fanning mill, constructed with about the same regard to mechanics as the rudimentary machines described above. The grain, divested of husk, is now ready for the scouring

process, which is done in stone mortars, holding about a bushel. These are set into stonework level with the floor, at an angle of about 30 degrees, twenty or more being distributed about, according to the size and shape of the room. A wooden framework is built over the mortars in such a way that a stone pestle, weighing twenty-five pounds, fixed to a beam pressing over a fulcrum, is rapidly dropped upon the grain. This is accomplished by a workman, who steps quickly upon the short end of the lever, and as quickly removes his weight when the pestle has been elevated to the highest point. The number of strokes considered necessary for this part of the process varies with the kind of rice, from two to four thousand. Ashes made from rice husks, to the amount of one-fourth of a pound, are added to each mortar of grain at the beginning of the pounding, and a second time when the pounding is half finished, the rice by this time having become quite warm. It is now taken from the mortar to be sifted, after which it is replaced for foot-scouring, ashes being added for the third time. A bare-footed workman, supported from falling by reclining in a kind of swing, treads in the mortar, which causes a rapid movement of the rice. This is continued for from thirty to forty minutes, when it is taken out and sifted, and is now ready for market. A part of the dust, composed of ashes and disintegrated rice, resulting from the scouring, is combined with 10 per cent. of salt and used in preserving vegetables. What remains is given to swine. Consul Simon says that, crude as these appliances are, they accomplish the work with the least breaking and crushing of the grain possible, and no doubt comprise most of the principles upon which rice-cleaning machinery is, or should be, constructed. The rice merchants in Hong Kong say that owing to the cheapness of labour, improved machinery propelled by steam, such as is in use in Bangkok and Saigon, would not be profitable in Hong Kong, and would not be permitted in China, where a vast number of people find, in rice-cleaning, their only means of earning a living.

THE FOUNDLING ASYLUMS OF FRANCE.

Of all European countries, France has established the greatest number of orphan asylums. The French laws relating to the establishment and maintenance of foundling asylums are found in their proper classification, says Consul Knowles of Bordeaux, under the head of *assistance publique*, and are the decrees of January, 1811, the memorandum of February, 1823, the decree of March, 1852, and the law of May, 1869. These statutes state that *enfants assistés* shall include, in addition to orphans and foundlings, properly so-called, whatever infants may be brought by their parents, irrespective of their legitimacy. The asylums in France are departmental, not communal, institutions. The State pays only the cost of

inspection and superintendence. The department in which the asylum is situated is liable for the following expenses:—(1) Temporary assistance to unmarried mothers, in order to prevent desertion; (2) allowances to the foster fathers in the country for board; (3) clothing; and (4) expenses for physicians, burials, &c. In 1889, the total cost throughout the country of maintaining the asylums was 11,300,171 francs (£452,000), of which 2,570,171 francs were paid by the asylums themselves, and 8,730,900 by the departments. This represented the support of 67,000 children. During the same year there were 25,000 abandoned children in France. Of these, 585 were taken back by their parents—343 by the mothers, 166 by the fathers, and 76 by relatives. Only 219 were legitimate. The professions of the women who abandoned their infants are represented as follows:—Cooks, housemaids, and other servants, 1,398; seamstresses, 917; women working by the day, 418. The *assistance publique* of Paris is specially provided for by the law of 1849; the management consists of a director appointed by the Minister of the Interior, a number of sub-directors, visiting physicians, &c. The asylum receives, on an average, 4,200 children a year—1-200th part of the entire birth-rate of the entire population of France. The expense of keeping a single child for twelve years is estimated at 1,500 francs (£60). It is understood that the children are kept until the age of twelve, in order that they may be reclaimed by their parents should these so desire. The *droit de recherche*, that is, the right of reclaiming a child, is conceded to the parent upon the payment of a small fee. Should, however, the child remain unclaimed up to the age of twelve years, he is considered an orphan, and is apprenticed by the authorities to a peasant or artisan.

Correspondence.

THE "TUGHRA" OF THE SULTANS OF TURKEY.

With reference to the discussion revived by Mr. W. J. Linton, in his recently published "Masters of Wood Engraving," on "the beginnings of engraving," I venture to offer for record in the *Journal of the Society of Arts* the following observations on the subject, founded on my studies of Indian art. They have been immediately suggested by the learned Mr. Hyde Clarke's interesting note in the *Athenæum* of the 1st inst., with reference to Mr. Linton's argument, on the *tughra* of the Sultans of Turkey.

To say nothing of wood-block printing on cloth, which is one of the most ancient ornamental arts of India, it is certain that the people of the East (including Egypt) have been accustomed to use incised metal and stone, and cut blocks of wood, of the

character of our butter "prints" and the Scandinavian bread "prints," for the purpose of reproducing on linen, cotton, paper, leather, &c., impressions by means of ink (*i.e.*, originally "encaustum," the vermilion used for the signature of the Romans Emperors of Byzantium) or other pigments, of the authentic superscriptions, or subscriptions—whether consisting of the graphically reproduced written names, or the monograms, or personal badges—of those employing such stamps as signet seals; or, again, for the purpose of marking the foreheads, and arms, and breasts of men, and the foreheads and flanks of cattle, with the symbol of the deity to which they are dedicated. This is commonly done in India by manual printing and by branding; but it is also everywhere done both on man and beast by signet printing.

Of course the earliest impressions of signet seals were on clay and other plastic substances; and we need not go to the discoveries made in our time at Nineveh and Babylon for proof of this. The practice is distinctly referred to in the ancient Book of Job, xxxviii. 14:—"It is changed as clay is under the seal." The quotation continues:—"And all things stand forth as in a garment": as if the passage referred also to painted or printed cloths [chintzes], or to figured brocades, like the costly *kincohs* of India. But there is the fullest evidence that, from a very early date, the ancient signet was also imprinted on leather, cloth, paper, leaves, parchment, and other materials employed for writing on at different times and places; as in the case of the letters sent by Jezebel to Ahab, and "sealed with his seal" (1 Kings xxi. 8), and of the letter King Ahasuerus desired Esther and Mordecai to write in his name, and "seal it with the king's seal" (Esther viii. 8-10). And this is the way in which the signet ring or stamp is, to this day, almost universally used throughout the East. A little Chinese, or other ink, is smeared over it with the finger, and then it is applied to the paper, parchment, cloth, or leather it is required to authenticate, the spot on which it is impressed being first softened with a little moisture from the tongue, except in the case of Hindus, who are scrupulous to use only water for the purpose. But the saliva, after all, serves as a protective size. Besides the name of the signatory, the signet bears also, more especially in Mahomedan countries, some such phrase of consecration as "God most Holy" (*cf.* Exodus xxxix. 30); "God most True" (*cf.* Gospel of St. John iii. 33), &c. The stone thus engraved is red or white carnelian, or, most prized of all, green jasper. This was the favourite signet stone of the Phœnicians; and the name Pliny gives it of "Molochites," is not derived, as he states, from *moloché* the "mallow," but, transparently, from Moloch or Molech (*malik*, the "Lord"), in his local form of Mel-carth [Melicertes], the tutelary "Lord of the City" of Tyre, to whom the green jasper was sacred, Where many signatures have to

be applied to a document, the space for them is ruled out with the thumb nail in chequers, each for a separate signature. The simple diaper thus formed is often most pleasing to the eye, and possibly first suggested the ornamentation of surface by diapering; as certainly the word "diaper" itself is derived, not from the city of Ypres in Flanders, once famous for the manufacture of the figured linen denominated "diaper," but from the Hebrew word *jaspel*, the "jasper," through the Italian *diaspro*; the very stone used from the earliest ages for signet seals. Various coloured jaspers were, in Byzantine times and all through the Middle Ages, used for decorating all sorts of sacred objects, until any iterated ornamentation, whether in illuminated painting, inlaid work, carving, embroidery, or weaving, came to be called a diaper; and it may be from this use of the stone, and not directly from its use as a signet seal, that the term originated. But in its latter use we seem at least to directly trace the secret incunabula of the diapering characteristic of the earliest types of oriental bookbinding.

I have now before me four Hindu seals of metal, cast in open work, as if formed of flattened wire, bent to the figures required. Two are for impressing ordinary signatures, and are, practically, compound printing types, and two are for applying sectarial marks on the foreheads of religious devotees. Similar to these are the larger metal stamps used for branding cattle with the awful trident of Siva, or the glorious disc of Vishnu. There is a reference in the Vedas to the marking of cattle with the sign of the *swarika*, which the modern Hindus identify with the "Seal of Solomon." The Kols, Mhangs, and other wild tribes of India, certify documents required to be signed by them with such symbols as representations of daggers, bows and arrows, &c., cut on wood blocks, or on metal, with a short handle. They do this because they cannot write; but the signet seal is equally used in the East by those who can write, and its attestation is held to be of higher authenticity than the signatory's sign manual (*cf.* "Timon of Athens," II. ii., and "Hamlet," V., ii.)

Both forms of sealing, namely, by printing with ink, and by impressing sealing wax, are often simultaneously used in India—the former (= "secretum") for the signature to a letter, and the latter for the "great seal" attached—after the manner of the metal (lead, silver, and golden) "bulls" of the Byzantine and German Emperors and Roman Popes—to the strings, fastening the brocaded (*kinco*) silk envelope of the letter.

With reference to the *tughra*, or cypher of the Sultans of Turkey, the Turkish tradition is that it represents the actual sign manual of Amurath I. (1360-89), on the treaty he signed with the Republic of Ragusa, in 1365. This was subsequently converted, after the manner of the ingenious cryptographers of the East, into the imperial monogram of the Sultans, of which the constant elements are the phrases, "the ever Victorious Lord," and

"son of," and the inconstant elements the names (= "secreta") of the reigning Sultan and his father. The *tughra* is not stamped, but inscribed on all state documents by the "Cypher Master," who is one of the three foremost functionaries of the empire. It is indecorous—although quite unintentionally so—of Mr. Hyde Clarke, as well as a little misleading, to compare him with a "chaffwax" or "deputy-chaffwax." It would even be derogatory to compare him with a "Writer to the Signet;" for the comparison is rather with the Lord Chancellor, as Keeper of the Great Seal. It is still, as it always has been in the immemorial East, a mark of the greatest confidence to make over to another the duty or privilege of using your seal, or of inscribing your signature; a usage of which we have a familiar illustration in the Biblical legend of Pharaoh and Joseph (Genesis xli. 42). No official of the Sublime Porte is, in fact, of higher dignity and trust than the *nishani-bashi* ("Cypher Master"); and it is as incorrect to distinguish him by Mr. Hyde Clarke's minimising title as it would be to designate Joseph, who in virtue of his office of bearer of the royal seal was Viceroy of Egypt, as "chaffwax" to the Hyksos Pharaoh Apophis.

Ismail, the Vizier of the Seljukian Sultan Masud of Irak, was surnamed Tughrai, on account of his great excellence in *tughra* writing; and his Arabic poem on the subject was once celebrated throughout Christendom under the name of "Carmen Toghræi." The Vizier of Masud's brother Mahmud was so jealous of Tughrai's proficiency in this peculiar cryptography, that he had him killed in cold blood after the battle in which Masud was defeated by Mahmud, A.D. 1120.

GEORGE BIRDWOOD.

Aug. 29, 1891.

Obituary.

LEONARD C. WYON.—Mr. Wyon, the eminent medallist, who had been a member of the Society of Arts since 1852, died suddenly on Thursday, 20th August. He was the son of the late Mr. William Wyon, R.A., chief engraver to the Mint, and was born at the Mint in 1826. He was educated at Merchant Taylors' School, and in 1843, when only 17 years of age, he was appointed assistant engraver to the Mint. On his father's death, in 1851, he became modeller and chief engraver. He also succeeded his father as engraver to the Goldsmiths' Company, and was subsequently appointed engraver to the Assay offices of Birmingham, Sheffield, and Chester. Mr. Wyon's whole life was passed in the designing of coins and medals, and the list of his works is a long one. For many years he produced all the medals of the Society of Arts,

Journal of the Society of Arts.

No. 2,025. VOL. XXXIX.

FRIDAY, SEPTEMBER 11, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

The following information respecting the Department of Fine Arts has been received from Chicago:—

RULES AND REGULATIONS.

Approved July 13, 1891.

SECTION I.

Duration.—The Department of Fine Arts of the World's Columbian Exposition will open in Chicago, May 1, 1893, and will close October 30, 1893.

SECTION II.

Classification.—It will be open to such works of American (United States) and foreign artists, whether previously exhibited or not, as may be classed under the head of Fine Arts, under the following schedule:—

DEPARTMENT K.—FINE ARTS: PAINTING, SCULPTURE, ARCHITECTURE, AND DECORATION.

Group 135.—Sculpture.

Class 770. Figures and groups in marble; casts from original works by modern artists; models, and monumental decorations.

Class 771. Bas reliefs in marble or bronze.

Class 772. Figures and groups in bronze.

Class 773. Bronzes from *cire-perdue*.

Group 136.—Paintings in Oil.

Group 137.—Paintings in Water Colour.

Group 138.—Paintings on Ivory, on Enamel, on Metal, on Porcelain or other wares; Fresco Painting on Walls.

Group 139.—Engravings and Etchings; Prints.

Group 140.—Chalk, Charcoal, Pastel and other Drawings.

Group 141.—Antique and Modern Carvings: Engravings in Medallions or in Gems; Cameos; Intaglios.

Group 142.—Exhibits of Private Collections.

SECTION III.

The following will not be admitted:—

1. Copies, even though they be reproduced in a class different from that of the original. For example, engravings obtained by industrial processes.
2. Pictures, Drawings, or Engravings not framed.
3. Works of Sculpture in unbaked clay.

SECTION IV.

The Department of Fine Arts shall consist of:—

1. An American (United States) section.
2. A section for each foreign country which is represented by a general commission, or by a national committee.
3. A section comprising exhibits of private collections, and the works of artists of non-represented foreign countries, whose works may be admitted under the provisions of Section IX.

SECTION V.

American.—American (United States) artists must deposit—or cause to be deposited—with the Chief of the Department of Fine Arts, before November 1, 1892, a list, signed by them, of such works as they desire to exhibit. A separate list should be made for each group and class, strictly following the schedule in Section II. Artists will be duly notified when their works must be sent in for examination by a jury to be appointed in future.

SECTION VI.

Works of American (United States) artists, produced since 1876, which have passed the examination of juries of exhibitions of acknowledged standing, will be admitted on list, should the jury so determine. An examination of lists will be made at an early day after November 1, 1892. Artists whose works may be admitted under these conditions will be at once informed by the Chief of the Department of Fine Arts. Works accepted must be delivered at the receiving gate of the Building for the Fine Arts on or before March 1, 1893.

SECTION VII.

Foreign.—The Department of Fine Arts, or its representatives, will be responsible for simple interior decoration of the galleries of the Art building. Special decoration or arrangements in lighting, &c., differing from those provided, will be executed at the expense of the National Committee of the country asking for it, and under the joint direction of the foreign representative and the architect of the Art building.

SECTION VIII.

The Chief of the Department of Fine Arts will not correspond with the artists of countries represented by general commission or national committees. The works of these artists will be admitted only through general commissions or national committees having in charge their reception and return.

SECTION IX.

Foreign artists—natives of countries not represented by a general commission or national committee—should address their request to the Chief of the Department of Fine Arts before July 15, 1892. They should notify him of the number of works they wish to exhibit, the subjects and dimensions, including frames. They will then be informed where to send their works for examination by a special jury, who will pass upon the admittance of all such works. In the case of works that have already passed the juries of exhibitions of acknowledged standing, and have been exhibited, action will be taken by the jury at an early day after July 15, 1892. A notice of the action of the jury will be sent to the artist at once. Works accepted must be delivered at the receiving gate of the Building for the Fine Arts on or before March 1, 1893.

SECTION X.

General.—Packing and transportation of all works will be at the expense of the exhibitors, unless special arrangements are made through private enterprise or public effort. A special rule for the guidance of those sending works, giving information in regard to packing, marking, and shipping, will be furnished on application.

SECTION XI.

When a sufficient number of works (pictures) are contributed by one artist to warrant such arrangement, an effort will be made to hang them in one group.

SECTION XII.

A card of admission will be issued to each exhibiting artist, entitling the holder to the use of the grounds, when open to the public. This card must be signed by the holder, and must be shown to the attendant when asked for.

SECTION XIII.

The custodian of the Art building will have the care and protection of works of art. Guardians of the gallery will be subject to his direction. He will use all due vigilance to insure the safety and protection of works of art against theft or damage.

Information as to special insurance, &c., will be given on application.

SECTION XIV.

Works of art will not be sketched, photographed,

or reproduced, except with the written permission of the exhibitor, countersigned by the Chief of the Department of Fine Arts.

SECTION XV.

The number and character of the honours conferred will be announced later; also the appointment of the Jury of Awards.

SECTION XVI.

Works of art must remain in the Exposition until its close, unless removed by a special permit, signed by both the Chief of the Department of Fine Arts and the Director-General.

SECTION XVII.

All works exhibited must be removed within a reasonable time after the close of the Exhibition. They will be delivered only on the presentation of the original receipt.

SECTION XVIII.

The building for the Fine Arts is a bonded warehouse, and all works of art will be received within its walls subject to the inspection of the customs officials, but without the payment of duty. They will be received and sent out in bond.

In cases where pictures or other works of art are sold, to remain in the United States in the possession of private individuals, duty will be paid in accordance with the customs laws governing such cases.

SECTION XIX.

It is understood that artists, either native or foreign, becoming exhibitors, thereby accept the conditions stated above, and agree to comply in every respect with the above requirements.

HALSEY C. IVES,

Chief of the Department of Fine Arts.

APPROVED:

GEO. R. DAVIS,

Director-General.

Proceedings of the Society.

CANTOR LECTURES.

PHOTOGRAPHIC CHEMISTRY.

BY PROFESSOR R. MELDOLA, F.R.S.

Lecture III.—Delivered March 23rd, 1891.

The photochemical studies which have been dwelt upon in the last lecture lead up to the consideration of the silver compounds, which

must of course receive special treatment on account of their present importance in photographic processes. The broad facts that silver nitrate darkens on exposure to light when in contact with organic matter, that the silver haloids become coloured when exposed under suitable conditions, and that other salts of silver, both inorganic and organic, also darken on exposure, will form the experimental basis from which the student may be led to the further consideration of the subject. At the outset of this work it is desirable to point out that our knowledge respecting the action of light on the silver compounds is in a different position to that concerning the simpler cases of photochemical decomposition which have hitherto been discussed. In the latter the chemical change is definite enough to be represented by ordinary equations, the composition of the final product being in most instances known. In the case of the silver salts we possess no such accurate knowledge, and the nature of the products is still surrounded by mystery.

When light falls on the silver haloids chemical decomposition takes place, accompanied by a change in colour. In order that this statement may be properly realised, let it be shown that there really is decomposition, and that the chloride and bromide under these circumstances give off a gas which blues starch and potassium iodide paper.* The iodide does not undergo decomposition on exposure except in the presence of an iodine absorbent, *i.e.*, a sensitizer. From these facts a good lesson can be conveyed concerning the general nature of the action of sensitizers. Passing on to the action of light on films of the haloids, it is possible, by means of a few simple experiments, to demonstrate many important properties of these compounds with which the student should be familiar. For this purpose sheets of paper, well coated with the pure haloids free from excess of silver nitrate, and a few ordinary reagents, are the only requisites. By one operation it can be shown that with the same exposure the chloride becomes darker than the bromide and the latter darker than the iodide, and at the same time that reducing agents and halogen absorbents accelerate while oxidising agents retard the decomposition. Thus three strips coated respectively with the three haloids may be painted with stripes of solutions of (1) sodium nitrite, (2) sodium sulphite, (3) silver

nitrate, (4) mercuric nitrate, (5) potassium dichromate. After exposing these strips simultaneously to the action of light, the stripes 1 and 2 will be darker than the ground-colour, showing the accelerating action of the reducing agents, 3 will also be darker than the ground-colour, showing that a halogen absorbent may also act as an accelerator without necessarily being a reducing agent, while 4 and 5 will retain the original colour of the haloid, showing the retarding action of oxidising agents. A comparison of the ground-colour in the three strips will also serve to show the different colours of the products of photochemical decomposition.

Such demonstrations as these cannot fail to impress the mind that the action of light on the silver haloids is a distinct case of photochemical decomposition, but it is necessary at this stage to issue a caution. The action is in these cases continued up to the point of visible darkening, whereas in the photographic film the exposure is so short that no directly visible effect is produced. It must be enforced therefore, that in associating the photographic image with these darkened products we are drawing largely upon arguments from analogy, and although I personally am inclined to the opinion that the products are the same in both cases, this view cannot be taught as a dogmatic truth in the present state of knowledge, for however probable it may appear from analogy it must not be forgotten that in the way of direct proof there is still a gap which must be bridged over before the identity of the products can be taught as an established fact. But the full consideration of this question is better deferred till the photographic film itself comes to be dealt with. The point that will now present itself is the actual composition of the darkened products, and here it may at once be pointed out to the student that our knowledge respecting these compounds is in precisely the same state as that concerning the coloured haloids dealt with in the last lecture. In the case of the darkened chloride, it has been proved that this product contains a little less chlorine than the normal chloride. In all three haloids, no matter how long the exposure may be, the final product always contains an enormous excess of unaltered haloid. It may safely be asserted that these products are not chemical compounds in the ordinary acceptance of the term, since they are not composed of the haloid combined with the coloured product of photochemical decomposition in definite molecular propor-

* "Chemistry of Photography," pp. 65-66.

tions.* Neither can the "photosalts" be classed with the definite "molecular compounds" of modern chemistry, since the latter also consist of substances combined in definite molecular proportions, and can be more or less readily resolved into their constituent molecules by appropriate treatment. But the "photosalt" cannot be resolved by any such treatment, since all solvents which dissolve the normal haloid appear to decompose the darkened product, leaving only a trace of metallic silver. On the other hand, metallic silver cannot be extracted from the "photosalt" by any of the ordinary methods.

In answer to the question which the inquiring student would naturally put, what is the photosalt, it can only be said that these products must be regarded as indefinite molecular compounds of the silver haloids with coloured unstable products of photochemical decomposition, the composition of the latter being as yet unknown. That the coloured products are unstable appears from the fact that they cannot exist apart from an excess of the normal haloid. In the same way that a solvent will take up a solid till the point of saturation is reached, so the silver haloid, on exposure to light, becomes decomposed up to a certain point, *i.e.*, the point when the haloid is saturated with the coloured product of photo-decomposition.† Beyond this point the action of light produces no further effect unless a reducing agent is present capable of combining with the liberated halogen as fast as the latter is liberated. It is advisable to let the student observe for himself that silver iodide prepared with excess of potassium iodide undergoes no change of colour on exposure to light, but that in the presence of silver nitrate or reducing agents, darkening occurs. Let him observe also that the darkened chloride yields no appreciable quantity of silver to dilute nitric acid, but that in the presence of a strong reducing agent, even

when the latter is gaseous, such as hydrogen, the reduction may proceed up to the complete liberation of the metallic silver. This last point can be demonstrated very conveniently by placing some finely divided silver chloride (prepared by precipitation) into a glass tube through which a current of moist hydrogen is kept passing, the gas being made to bubble through a solution of silver nitrate containing free nitric acid. On exposing the contents of the tube for some time to strong light, silver chloride is precipitated from the solution of the nitrate, the chloride in the tube (which should be shaken from time to time in order to expose fresh portions) gradually becoming dark coloured. An equal quantity of the chloride may be exposed in air at the same time for comparison. The two lots of darkened chloride are then treated with equal quantities of dilute nitric acid, the clear solution filtered off, and the filtrates tested for silver. If the experiment has been properly conducted, the solution from the chloride darkened in hydrogen will be found to contain distinct traces, while that from the chloride darkened in air will be free from silver. It is hardly necessary to point out that the chloride used in this experiment should be free from excess of silver nitrate, *i.e.*, prepared with an excess of a soluble chloride, or chlorhydric acid.*

* The above experiment is a modification of one described by Robert Hunt ("Researches on Light," 2nd ed., p. 78). This method has recently been applied by R. Hitchcock ("Amer. Chem. Journ.," xi, p. 474), for determining quantitatively the loss of weight in films of silver chloride, exposed to light in an atmosphere of hydrogen. The author considers that his experiments prove that oxygen does not enter into the composition of the darkened product, *i.e.*, that they disprove the oxychloride theory. But since water vapour was present, and was indeed found to be indispensable for the photo-decomposition, this inference cannot be allowed much weight. Moreover, since hydrogen is known to reduce the chloride to silver under the conditions of the experiment, the darkened product may have a different composition to that formed in air: it may consist of reduced silver, mixed with unaltered chloride. (See also C. H. Bothamley in "Brit. Journ. of Photog.," April 4th, 1890.) Hitchcock's films were prepared by allowing finely-divided silver chloride, obtained by precipitation, to subside on glass. (Herschel and Hunt's method). After being washed and dried under a desiccator, the films were but slightly darkened in dry air, even after an hour's exposure to bright sunlight. The introduction of water rapidly increased the rate of darkening, thus furnishing another illustration of the very familiar fact that water acts as a sensitizer. This point was illustrated during the lecture by two experiments, conducted simultaneously. Strips of paper, coated with the chloride and bromide respectively, were partly screened by black paper, the exposed portions being partly wetted with distilled water. The chloride paper was allowed to remain exposed to the electric light till visibly coloured; the bromide paper was withdrawn, after a few seconds and developed with weak ferrous oxalate developer. In both strips the portion wetted with water was distinctly darker than the exposed dry part of the coated paper.

* It must be recognised that the definite character of molecular compounds passes into the indefinite when we have $\frac{1}{2}$ H₂O, $\frac{1}{2}$ C₂H₄O₂, $\frac{1}{2}$ CH₄O, &c., in crystalline products.

† The analogy between a photosalt and a saturated solution was indicated in a lecture delivered last year at the Royal Institution ("Proc. Roy. Inst.," vol. xiii, p. 143). The idea of a "solid solution" may appear somewhat strained, and I am glad, therefore, of the present opportunity of calling attention to a similar idea which has occurred to others in connection with a totally different branch of chemistry, *viz.*, the affinity of colouring matters for fabrics. This notion has been expressed by Dr. E. Knecht ("Journ. Soc. Dyers and Colourists," 1889, p. 77), and recently it has been extended with considerable force to the theory of dyeing by my friend Dr. Otto N. Witt ("Färber-Zeitung," 1890-91, Part I.).

Having arrived at the conclusion that the silver haloids, when exposed to light under suitable conditions, lose a small quantity of their halogen, and become converted into coloured compounds, the course of instruction will here naturally diverge along two lines:—

(1.) The nature of the coloured product combined with the excess of unaltered haloid; and

(2.) The part played by the associated substance or sensitizer.

With regard to the first, it must be pointed out that, although we have no positive information of a conclusive character, many views have been advanced, which are more or less worthy of consideration; and an excellent exercise in the use of scientific judgment might be given to the advanced student, by submitting the current notions respecting the composition of these products, and requesting him to prepare a critical essay embodying his own views. Although no definite conclusion might be arrived at, the exercise cannot fail to be of value as an educational test, not only by compelling the student to refer to original papers, but also as calculated to bring out any originality he may possess in the way of devising new crucial experiments—the highest criterion of competence as a technologist. Respecting the view that these compounds contain metallic silver, the fact that the chloride darkens under nitric acid may be taken as evidence to the contrary.* The discussion of the possibility that sub-haloids are present, will link this part of the subject on to the purely chemical considerations dealt with in the last lecture. The possibility of the coloured products containing oxygen, *i.e.*, being of the nature of oxyhaloids, is also worthy of being entertained.† In favour of this view is the analogy of cuprous chloride, which darkens only in media which can supply oxygen, and which, under these circumstances, apparently forms an oxychloride. In the same sense may be interpreted the distinct sensitizing action of water already referred to.

* Ostwald unhesitatingly affirms, both with respect to the wet collodion and gelatino-bromide emulsion processes, that traces of metallic silver are liberated by the action of light. ("Grundriss der allgemeinen Chemie," pp. 262-263.")

† According to a recent research by Dr. A. Richardson ("Journ. Chem. Soc.," vol. 59, p. 536), the chloride darkened under water does not contain oxygen. I learn, however, from Mr. H. B. Baker, of Dulwich College, that he has come to an opposite conclusion. His experiments are not yet completed, but he considers that the evidence in favour of the view that the darkened chloride contains oxygen is quite conclusive. He has measured the oxygen absorbed and the oxygen evolved by the action of chlorine on the darkened product.

On the other hand, it may be pointed out, that the chloride darkens in a high vacuum (*i.e.*, in the presence of mercury vapour), and under liquids such as pure benzene, petroleum, and carbon tetrachloride, which contain no oxygen, and which have previously been dried by chemical methods. The question thus assumes the form, whether the nature of the coloured products may not vary in different media; whether, in easily halogenised liquids, such as benzene, the reduction might not be analogous to that which occurs in hydrogen; whether, in other cases, the unsaturated silver haloid residue may not form a coloured compound with the organic product; and so forth. It may be pointed out that such questions as these open a wide and interesting field for experimental investigation.

With regard to the second point, the action of the substance associated with the silver haloid—it is legitimate to connect this action with the ordinary chemical processes with which the student has been familiarised. He has been taught that reduction and oxidation are concurrent in ordinary chemical reactions, such as when a silver salt is reduced by a ferrous salt. The principle can now be extended to photochemical reactions. With the exception of a few cases of pure dissociation (such as the resolution of gold oxide into metal and oxygen under the influence of light), which have no direct bearing on photographic processes, the photochemical changes with which the photographic chemist has to concern himself may all be considered from the same point of view as those which have been made use of by way of special illustrations. There is no fundamental difference in principle between the action of light on a mixture of ferric chloride and oxalic acid, or mercuric chloride and ammonium oxalate, and its action on a silver haloid mixed with water, silver nitrate, sodium sulphite, gelatine, or any other organic compound capable of being oxidised or halogenised. The only differences are in the relative velocities of chemical change, and in the circumstance that in the case of such metals as iron and mercury the products are definite and known, while in the case of silver the products are indefinite and unknown. The student will thus be led, without a break, from ordinary chemistry to photochemistry, and from the latter to the chemistry of photographic processes. He will now realise that the photographic film is to be looked upon as a system of chemical compounds capable of undergoing atomic rearrangement under the influence of

the external energy of light. He will grasp the full meaning of the term "sensitizer," and he will see that the function of the latter is quite as important as that of the silver haloid itself.

From this point the practical study of photographic methods, the preparation of emulsions and films, the uses of collodion and gelatine as vehicles, the action of preservatives, and all the technical details of modern processes can be taken up or resumed. Then in natural sequence will follow the consideration of the nature of the photographic image and its connection with the coloured products resulting from the prolonged action of light on the silver haloids. At this stage, again, caution is necessary, and dogmatic statements must be avoided. The action of light on the sensitive films in use in photography, including all the films employed for producing pictures in the camera, from the iodised silver plate of Daguerre to the gelatino-bromide plate of modern times, gives rise to no visible product of photochemical decomposition. Is it therefore legitimate to conclude that the short exposure necessary to give a developable picture produces any photochemical decomposition at all? It must be pointed out that there is here another gap in the way of direct proof, but that the indirect evidence is all in favour of there being such a chemical change. Of the nature of the material composing the invisible image we know no more than we do of the composition of the coloured products of photochemical decomposition, or of the photosalts. They may be identical or not; but that the image is the result of a true chemical change can be made to appear highly probable to the student by a few well-chosen demonstrations. Let us consider the evidence as it stands.

The invisible image is either the product of chemical decomposition, or it is not. If it is not, then some other explanation must be invoked. The only other view is that the energy of light is not at first used up in doing chemical work, but that before true chemical decomposition occurs there is an intermediate stage, during which the energy is engaged in loosening the affinity between the atoms of the halogen and the silver. This would be analogous to Bunsen and Roscoe's "photochemical induction." According to this, view we should have to regard the first action of light on the sensitive film as a purely physical action, resulting in the formation of an unstable modification of the silver haloid, more easily reducible than the ordinary modification. It

might be thought that such a physical modification would be easily producible by the limited action of light on the pure silver haloid, but as far as my own experiments have gone, this does not appear to be the case. By exposing pure, dry silver bromide films, obtained by the method already described, for sufficient time to produce a well-defined developable image on a photographic plate, no difference in the reducibility of the exposed and unexposed parts could be detected. In fact, the films of the pure haloid are so insensitive that an exposure to bright sunlight of sufficient duration to completely solarise the slowest of modern dry plates, showed no difference in reducibility by potassio-ferrous oxalate or alkaline-pyrogallol, between the exposed and unexposed portions of the surface. The conclusion to be drawn from these experiments is that in this form the silver haloid cannot be converted into a more easily reducible physical modification by any moderate exposure to light—certainly not by an exposure considerably greater than that necessary to impress an image on a gelatino-bromide plate.

At this point the question of molecular aggregation comes into consideration. Is it not possible that in the iodide film of the old collodion process, or in the gelatino-bromide emulsion, the silver haloid is in a different and more highly sensitive state of molecular aggregation? Is there, in fact, a more unstable condition of the haloid than that resulting from the action of the halogen on a silver mirror on glass? In considering this part of the subject attention may be called to the experiments which the student has already been recommended to make in connection with the modifications of the haloids. His experience in the preparation and ripening of emulsions will also render good service in enabling him to fairly consider the evidence. It is possible that some weight—how much it is not yet possible to decide—may have to be given to the state of aggregation as a factor in determining the extreme sensitiveness of the photographic film. At the same time it must be pointed out that no experimenter has ever yet succeeded in preparing a film of silver haloid in any state of aggregation free from every suspicion of a sensitizer, and capable of receiving an invisible and developable impression in the same time as an ordinary photographic plate.*

* According to Stas the third (granular) modification of AgBr (both the white and yellow forms) are extremely sensitive to light. He states that on boiling (with water?) in

We are thus brought face to face with the remarkable fact that a film of pure dry haloid gives no product which is more easily reducible than the original haloid by any reasonable amount of exposure to light. Let the same haloid be diffused in fine particles throughout a sensitizing vehicle such as collodion (with the necessary preservative) or gelatine, and an exposure for a few seconds or a minute fraction of a second gives a product which is far more readily reducible than the unexposed haloid. It may be pointed out that it is extremely difficult to see where the necessity for invoking the physical theory of the photographic image comes in when these facts are fairly weighed.* The facts them-

a glass flask they become darkened in two or three seconds by the blue flame of a Bunsen burner. It is not clear from the description whether he attributes the darkening to the light of the burner alone, but the conditions are obviously very different from those which exist in a photographic film. It would be of interest and importance to reinvestigate this modification of AgBr from the photographic point of view. With reference to the production of an invisible image on a film of AgI on glass, opinions are divided (compare Abney, "Treatise on Photog.," 5th ed., p. 25, and Eder, "Handbuch," Part II., pp. 11 and 20). The authority for the statement that such an image can be produced is Carey Lea. In order to submit the question to the test of experiment I have made, with the co-operation of Mr. T. H. Norris, some further experiments with iodized silver mirrors on glass. The results with alkaline developers are the same as those with the brominated mirrors; there is no difference in reducibility between the exposed and the unexposed portions of the film. With an acid developer, however, a developable image is produced. A plate was half covered by a black screen and the uncovered portion exposed for five minutes to the light of the electric arc. The developer was the ordinary pyrogallol solution with acetic acid as a restrainer and a few drops of AgNO solution. The silver deposit formed on the exposed portion long before the unexposed half was attacked. This confirms Carey Lea's results, and at the same time opens up a very wide question, viz., whether photochemical decomposition is necessary for development by accretion as distinguished from development by reduction. It may be that photophysical change is competent to give an image capable of accretional development. It is known that the silver haloid when crystalline is susceptible of photophysical change (Schultz-Sellack, *Pogg. Ann.*, vol. 143, p. 439).

* In his inaugural address to the Photographic Section of the Liverpool Physical Society (Jan. 19th, 1891, "Photography," Feb. 19th and 29th, 1891), Dr. F. Hurter states that it has always appeared impossible to him "to reconcile the short exposures necessary for the production of photographic images with any theory which demanded the absolute separation of the halogen, or part of it, from the silver." He bases his objections to this (chemical) theory on quantitative experiments, which go to prove that the energy supplied by the initial source of light is totally inadequate to account for the decomposition of the haloid, or the quantity of silver produced on the film by subsequent development. It does not appear to me, however, that these experiments or calculations in any way affect the chemical theory of the photographic image. The actual amount of photochemical decomposition, as measured by the quantity of silver produced on reduction may be, as the author states, connected with the initial source of energy by a logarithmic law. But this does not prove that no separation of halogen takes

selves can be easily demonstrated without any appeal to a photographic plate. It is only necessary to take one of the brominated silver mirrors and streak it with a dilute solution of gelatine, allowing the solution to remain for 10 or 15 minutes in contact with the film. The gelatine stripes can, if necessary, be kept moist by adding water from time to time. The plate is then exposed to strong light for a few seconds, washed with warm water to remove the excess of gelatine, and then developed with a weak ferrous oxalate solution containing plenty of potassium bromide. If the experiment has been properly made the stripe under the gelatine develops before the remainder of the film is attacked.

From this and many analogous experiments which might be made or quoted,* it will be made clear to the student that the function of the sensitizing vehicle is of a very high order of importance. It will be seen also that the particular vehicle now in vogue, gelatine, is a particularly good sensitizer, and it is legitimate to connect its sensitizing action with its well-known power of taking up bromine. It may be asked whether it is more probable that mere contact with a solution of gelatine should so alter the physical condition of the haloid (as in the last experiment) as to convert it from a comparatively insensitive to a highly sensitive physical modification, or whether it is more probable that the gelatine should act in the same way as the reducing agents used as sensitizers in the former experiment with the coated papers. It may, I think, be fairly taught that the balance of probability is in favour of the purely chemical action of the gelatine. In accordance with this view is the fact that no collodion emulsion, however the haloid may be modified in physical condition by "ripening," can be made as rapid as a modern dry plate. On the other hand, in favour of the view that some weight must be given to the state of aggregation, it may be pointed out that the silver bromide on glass, although considerably increased in sensi-

place; the energy is not to be regarded as acting upon AgBr alone, but upon a most intimate mixture or possibly even upon a compound of AgBr and gelatine. The latter substance is well known to combine with bromine to a very considerable extent (20.5—22.9 p.c.; see Weyl in *Chem. Centralbl.* 1878, p. 198, and Knop, *ibid.* 1879). The action of light on the photographic film is rather comparable with the action of heat on an explosive mixture or compound; the total energy evolved on the explosion of gunpowder is not dependent on the amount of energy supplied by the spark which determines the explosion.

* See Sect. III. of chap. x. of Eder's "Ausführl. Handb.," Part III.

tiveness by contact with a gelatine solution, is still much less sensitive than the emulsion.

If, therefore, it is regarded as improbable that mere contact with a gelatine solution can alter the physical condition of the haloid, it may be asked what happens during the ripening of an emulsion. The student will have learnt that when silver bromide is first precipitated in gelatine, the emulsion is comparatively insensitive. It is only by long contact with the gelatine solution at the ordinary temperature, or by the action of heat for a shorter period, that the emulsion acquires its maximum sensitiveness. It is believed by the majority of photographic chemists that the change which occurs during this process is a purely physical one—that there is a growth in size of the particles accompanied by corresponding changes in optical properties.* As already stated, it is possible that some such physical change of condition may occur, and that the increase of sensitiveness may be partly attributable thereto. The condition of the bromide particles in an emulsion is, from the beginning, very different from the condition of the bromide on a film prepared by brominating a silver mirror on glass. Nevertheless, I do not believe that we are at present justified in teaching dogmatically that the whole increase in sensitiveness is due to physical modification only. I must confess that, from experiments which I have been making, and which I hope at some future time to continue, that I am gradually coming round to the view that more and more weight must be given to the probability of combination between the silver haloid and the gelatine, and less weight to the state of molecular aggregation than has hitherto been conceded. If analogy is wanted in support of this view, it is only necessary to remind you of the existence of the “gelatino nitrate” of silver prepared in a former experiment. If gelatine can combine with silver nitrate to form a compound capable of photochemical decomposition, it is not unreasonable to suppose that a similar kind of compound might be formed from a silver haloid and gelatine, or some constituent of the gelatine, under the conditions essential for ripening an emulsion. It is desirable that the photographic chemist should be prepared for the proof, which may be at any time forthcoming, that the marvellous sensitiveness of the modern dry plate is not altogether due to the particular

state of aggregation of the silver haloid, but that the substance which is so sensitive to light is an organic silver haloid compound belonging to that indefinite “molecular” group so frequently met with in this branch of chemistry.

From this stage onward, the practical study of photographic processes may be carried on hand in hand with the demonstration of the chemical principles concerned. The photographic image will be regarded as being most probably composed of a product of true photochemical decomposition. This product may, or may not, be identical with the “photo-salts,” but it is not improbable that its composition may vary according to the nature of the vehicle with which the silver haloid is associated. The sensitive film which is now in general use will be regarded as a “gelatino-bromide,” in the same sense that the term “gelatino-nitrate” has been employed. The photographic image will be looked upon as a design on the surface of the gelatino-bromide, composed of a chemical product more easily reducible than the gelatino-bromide, and invisible simply because of the extreme tenuity of the deposit. When a reducing agent is applied, the material composing the invisible image is alone reduced to metallic silver,* and the picture is said to be “developed.” The subject of development may now be dealt with, and the chemical principles of the process demonstrated. It is necessary to commence by pointing out that a photographic developer may act in two distinct ways. In development by vapour, as in the Daguerreotype, and in the so-called acid developers, there is an accumulation of finely-divided metal (resulting from condensation in the case of mercury vapour, and from chemical reduction in the case of acid developers) on the material of the invisible image only. If, for example, silver nitrate is reduced by ferrous sulphate or pyrogallol, the pulver-

* It is well known that a reducing agent of sufficient strength to reduce silver bromide directly, such as the ordinary ferrous oxalate developer, may be applied with a gelatino-bromide dry plate. It is generally taught that the haloid is protected in such an emulsion by virtue of the particles being imbedded in the gelatine. I am disposed to believe, however, that the protection is not merely physical, but that the weak chemical combination between the haloid and the gelatine (or one of its constituents) results in the formation of a compound less reducible than the haloid itself. I may point out, incidentally, that the change in size of the particles, and the modification in optical properties undergone by the emulsion during the process of ripening, as well as the increase in sensitiveness, are all in accordance with the chemical theory of the gelatino-bromide film.

* For further particulars, see “Chemistry of Photography,” pp. 120-132.

ulent deposit of metal accumulates by preference on the product of photochemical action, and continues to be deposited thereon as long as there is silver being deposited from the developing solution. Where the silver deposit has once formed, there it continues to grow by accretion, and the developed picture is built up of metallic silver. The action is, doubtless, of an electrolytic character, the material of the invisible image, and the unaltered haloid forming the two elements of a galvanic couple, and the developing solution playing the part of the electrolyte. To illustrate the mode of action of developers of this class, it is only necessary to use one of the silver on paper designs produced as in the first lecture. An extremely faint design in reduced silver, on being immersed in a solution depositing the metal by reduction, becomes darker and darker by the process of accretion. In order to broaden the student's notions, it must be pointed out, and illustrated experimentally, that this process is not peculiar to silver. A design in any freely-divided metal, such as mercury, gold, or platinum, produced by reduction (chemical or photochemical) on a paper surface can be "developed" in the same metal, by immersing it in the solution from which the metal is being deposited by chemical reduction.

The other kind of development effected by such reagents as ferrous oxalate, alkaline pyrogallol, eikonogen, and hydroquinone, must be regarded as also due to reduction; but, in these cases, it is the material composing the invisible image which is directly reduced. This constitutes the so-called alkaline development. It must be taught, in connection with this subject, that the silver deposit which results from the reduction of the invisible image is not the exact equivalent of the quantity of material composing that image, but that the reduction commenced on the portions exposed to light extends downwards through the film as long as the developer is acting. In fact, it must be made clear that the silver deposit *grows* by continued reduction, the action in this case also being most probably electrolytic, the elements being the first film of reduced silver, the unchanged haloid with which it is in contact, and the developing solution as the conducting medium.

The final result of both kinds of development is the production of a silver picture, composed of far more silver than can be accounted for by the actual quantity of the material composing the invisible image. The two kinds of

development may be classified as "accretional" and "reductional" (chemical and physical, according to the Continental photographers). The broad principles of the process having been elucidated, the student may proceed to the study of the individual developers, their mode of preparation, and the probable chemical changes which they undergo when acting upon an exposed plate. In dealing with the latter point, it is not essential that the actual composition of the material composing the invisible image should be known; it is only necessary to regard the action as occurring between free halogen and the reducing agent in the presence of water. In the case of such a developer as ferrous oxalate the chemical change is sufficiently obvious, but the action of halogens and water upon organic reducers is far less definite, and it will be safer to abandon all attempts to represent the changes by equations in the present state of knowledge. It may be less satisfactory, but it is a more truly scientific attitude to confess imperfect knowledge than to invent nicely balanced equations which may be quite remote from the truth.

Having mastered the principles of development, it is important that the student should have his attention directed to certain phenomena which connect this subject with the initial action of light on the photographic film. He will have learnt from the previous demonstrations that the photographic image with which he is practically familiar is most probably a product of photochemical decomposition. He will thus be prepared for the proof that chemical reducing agents may act in the same way as light; that is to say, that by employing a very slow reducer and allowing it to act on the silver bromide for a short time, the reduction is carried to the same stage as that which results from the initial action of light. The process of reduction can be arrested at the invisible stage—at a stage intermediate between the haloid and the free metal. The product thus formed, whatever its composition may be, is more easily reducible than the original haloid, and can therefore be "developed" by ferrous oxalate, &c., in just the same way as the invisible image. The simplest way of showing this is to stripe a sheet of paper coated with the haloid with an alkaline solution of glucose, allow the latter to act for a few minutes, wash thoroughly, and then develop with weak ferrous oxalate containing plenty of soluble bromide. It may be pointed out that such a result as this, for the

experimental demonstration of which we are indebted to Carey Lea, is opposed to the physical theory of the photographic image, since it is difficult to see how the mere contact of a silver haloid with a feeble reducing agent can modify the physical stability of the haloid so as to transform it into a chemically unstable modification.

Another fact bearing on the present subject which must not be overlooked, is that mechanical force of the nature of a shearing stress also produces a developable impression on a silver haloid film. So far as my experiments have gone, this result cannot be produced except in the presence of a sensitizer; any of the ordinary photographic films will show it, but I have thus far been unsuccessful with the halogenised mirrors on glass. Although negative evidence does not count for much, it appears thus far that the effect is only producible under the same conditions that an invisible image is produced by light. If this be so, then we have an additional argument in favour of the chemical theory of the photographic image, for the researches of Prof. Spring of Liege have shown that a mixture of compounds can be made to undergo chemical interaction by mechanical pressure alone. The silver haloid and its associated or combined sensitizer provides such a mixture or compound.

In connection with the necessarily related subjects of exposure and development, the phenomenon of reversal must be dealt with. I regret exceedingly that time is pressing me towards a conclusion, and that I can do no more than hint at the mode of treatment of this important subject. I have already expressed the view* that this phenomenon is best regarded as reversed chemical action between the halogenised sensitizer and the material of the invisible image. Since that view was put forward three years ago, no new facts have been adduced which are in opposition to it, and I am therefore bold enough to think that it is at any rate worthy of being taken into consideration by the teacher of photographic chemistry. In the broadest possible terms all that we have to consider is that the "photosalt" in contact with a sensitizer containing more than a certain quantity of halogenising or oxidising material has the tables turned upon it, to speak metaphorically, and then acts as a sensitizer towards the film which at first acted as a sensitizer towards it. The principle can be demonstrated by utilising a

very old experiment. It is known that potassium iodide is capable of undergoing photochemical oxidation in the presence of moisture and air; iodine and potassium hydroxide are formed, and of course interact in the absence of some other iodine absorbent. A photosalt is an iodine absorbent, and therefore if a sheet of paper be coated with a silver haloid, and then exposed to light till it darkens, we have a surface capable of sensitising a solution of potassium iodide, so that the latter undergoes photochemical oxidation with extreme rapidity, the liberated iodine being absorbed by the photosalt which thereby becomes bleached, *i.e.*, converted into the ordinary haloid.

Having brought the student up to this stage of knowledge, we must leave him in possession of a silver picture produced by development, and the chemistry of the subsequent operations of fixing, clearing, intensifying or reducing, printing, toning, and so forth, will be comparatively simple, after the course through which he is supposed to have been conducted. With regard to these subsequent operations, all that has to be borne in mind is that, after fixing and washing, the image is composed of a graduated deposit of metallic silver, and that all the changes that are wrought upon it by intensifiers or reducers are simply the result of ordinary chemical transformations. Thus the principle of intensification may be demonstrated in the usual way, *viz.*, by producing a design in silver on paper, as in the first lecture, then bleaching it by immersion in a solution of mercuric chloride, and, after washing, converting the mercurous chloride formed into the dark dimercurous ammonium chloride. The final result is a more opaque image—the latter has become intensified.

I have, perforce, been obliged to keep rigidly to my programme in this course of lectures; there has been no time for straying into bye-paths, and I have confined myself strictly to the chemical aspect of the subject. I said, at starting, that it has also its physical side and the special action of the spectrum colours on the different photo-sensitive compounds, the electrical phenomena accompanying development, the action of special sensitizers in connection with orthochromatic photography, the subject of heliochromy, &c., must be included in every complete course of instruction in photographic technology. It has been my object to indicate the general lines on which this branch of technical training should be conducted; the teacher will no doubt discount the personal element from

* "Chemistry of Photography," pp. 209-230.

these lectures as far as he may think desirable, and after he has done this, if he will conduct the student along the broad track, towards which I have acted the part of a finger-post, we may call into existence a race of technologists who will raise the subject of photography to that high position as a science which it has already taken as an art.

Miscellaneous.

PRECIOUS STONES IN THE UNITED STATES.

It appears, from a report recently issued by the United States Census Office, that, up to the present, there has been very little mining for precious or semi-precious stones in that country, and then only at irregular periods. It has been carried on during the past few years at Paris, Maine; near Los Cerrillos, New Mexico; in Alexander county, North Carolina, from 1880 until 1888; and on the Missouri river, near Helena Montana, since the beginning of 1880. True beryls and garnets have been frequently found in the mining of mica, especially in Virginia and North Carolina. Some gems, such as the chlorastrolite, thomsonite, and agates, of Lake Superior, are gathered on beaches, where they have fallen from rock, which has gradually disintegrated, by the effect of the weather and the waves. A very limited number of diamonds have been found in the United States. They are met with in well-defined districts of California, North Carolina, Georgia, and Washington, and recently in Wisconsin; but, up to the present time, the discoveries have been rare, and purely accidental. Of the corundum gems (sapphire, ruby, and other coloured varieties) no sapphires of fine blue colour, and no rubies of fine red colour have been found. The only locality which has been at all prolific is the placer ground between Ruby and Eldorado bars, on the Missouri river. Of the beryl gems (emerald, aquamarine, and yellow beryl), the emerald has been mined to some extent in Alexander County, North Carolina. The turquoise, which was worked by the Aztecs before the advent of the Spaniards, and since then by the Pueblo Indians and largely used by them for ornament and as an article of exchange, is now systematically mined near Los Cerrillos, New Mexico. Its colour is blue, and its hardness is fully equal to that of the Persian, or slightly greater, owing to impurities, but it lacks the softness of colour belonging to the Persian turquoise. From time immemorial this material has been rudely mined by the Indians. Their method is to pour cold

water on the rocks after previously heating them by fires built against them. This process generally deteriorates the colour of the stone, to some extent tending to change it to a green. The Indians barter turquoise with the Navajo, Apache, Zuni, San Felipe, and other New Mexican tribes for their baskets, blankets, silver ornaments, and ponies. The finest garnets and nearly all the peridots found in the United States are found in the north-western part of New Mexico and the north-eastern part of Arizona, where they are collected from ant hills and scorpion nests by Indians and by the soldiers stationed at adjacent forts. Since the discovery of gold in California, compact gold quartz has been exclusively used in the manufacture of jewellery, at one time to the amount of about £20,000 a year. At present, however, the demand has so much decreased, that only from £1,000 to £2,000 worth is annually used for this purpose. The production of precious stones, minerals, &c., in the United States in 1889 was valued at about £38,000.

THE SACRED CITRON OF MOROCCO.

Her Majesty's Consul at Mogador says, in his last report, that there is a curious, rare, and highly-esteemed holy fruit grown in Morocco, which is sold there at an average price of fourpence the fruit, yet never appears to be eaten. This is spoken of as the sacred or holy citron of the Jews, which is carried to their synagogues at the feast of tabernacles, it having an emblematical significance. So highly prized is this fruit by the faithful observers of Israelitish tradition that specimens without blemish sometimes fetch as much as four shillings each, while in England, Consul Payton states that he is informed on good authority, they are sold in certain synagogues for the extraordinary price of one to two guineas each. Their use is supposed to be derived from injunctions contained in the 23rd chapter of the book of Leviticus, "And ye shall take you on the first day the boughs of goodly trees, branches of palm trees, and willows of the brook." But the Jewish version of the same passage reads, "And you shall take to yourselves on the first day the fruit of the tree hadar, palm leaves, boughs of the tree aboth, and willows of the brook." These special fruits, boughs, &c., are particularised in a Jewish book, entitled "The Festivals of the Lord, as fruit of the tree hadar or citron (Hebrew troon) the 'capoth temarim' or palm leaves, boughs of the tree aboth or 'myrtle' and brook willows." The "troon" or "tabernacle citron," as it is sometimes called, is a fruit larger than a lemon, pale greenish yellow in colour (being always plucked before it is ripe), and said to contain only one pip, and to be of an extremely pure nature, and to keep sound for a very long period. Those which are despatched from Morocco are carefully packed in cotton wool or other soft material, as the price which they realise for their

holy use is entirely dependent on the greater or less freedom from blemish which each specimen exhibits. Inquiry as to the exact locality of their production has resulted in fixing it at a place called Assats (sometimes Assat), which is in the province of Soos, at a short distance from the town of Tarndant, and on or near the bank of the great Soos River. It is stated with regard to this interesting place that there is a very ancient Hebrew graveyard there, and orchards known by the names of Moses, Aaron, David, &c., also that the authority of the Moorish Government is not respected there. Jewish informants have said that these "troons" come from no other place but Assats; but they have been unable to explain how the faithful Hebrews in many far distant parts of the world manage to provide themselves with these necessary emblems, the shipment of which from Mogador in one year amounted to a hundred and ten boxes, containing nine thousand and twenty-four specimens of this production.

Correspondence.

THE "TOGHRA" OF THE SULTANS.

On a casual observation of mine in the *Athenæum*, Sir George Birdwood has bestowed, at p. 809, a dissertation, framed with his accustomed erudition, and illustrated by his recondite Oriental research. He has, however, accused me of disrespect to the Cypher-Master, in comparing him to a Chaffwax, and I think I ought to retaliate with an accusation of his irreverence to the Chaffwax. In these degenerate days he counts but little; but his office was a patent office, and, above all, a sinecure, with good fees, which enabled him to appoint a Deputy-Chaffwax to receive them. I made an incidental reference to the hierarchy of the Chancellery. How far the Cypher-Master ranks with the Chancellor I do not know. I do know that he is independent of the Ministry, and that he is a person of rank and importance. I have been referred by the Grand Vizier to the Chancellor, who has power of delay, but never to the Cypher-Master. I do not compare the latter with the Keeper of the Great Seal, nor even of the Privy Seal. Whether he may be compared with the Keeper of the Signet I cannot decide.

Of course, a *Muhur* has to be kept, as Sir George says, with the greatest care; and the *Muhurdar* is a person of the greatest trust. I have no *Muhur* now, and my seal is of little use, but it is still kept in my purse, from old custom. As Sir George states, certain stones are valued for seals, and, in many cities, seals are sold in the Talisman Bazaar. Metal seals are made of brass among Mussulmans,

because a Mussulman ought not to have a gold or silver seal.

In the bazaar are to be bought seals with Mehemed, Ahmed, Ali, and all kinds of common names. They are of little value for identification, and yet, as of old, the seal is considered a greater protection against forgery than a signature. In the west, as in the middle ages, this practice was kept up, and hence it has been inferred that many a man of rank who could certainly have written his name was illiterate. A practice that favoured seals was that in a monastic charter a man made a cross, and a monk wrote the name of each. This mode favoured our monks in the middle ages in forging Anglo-Saxon charters of donation, and it was one suspected, but which could not be detected.

Sir George explains the mode of sealing, but even this has its dangers. We have to keep a sharp eye on the *Muhurdar*, or he may take sufficient ink on his thumb, not only to make the impression ordered, but to walk out with still sufficient ink to make another seal on a sheet of paper, to be used or sold on some future occasion.

The moral, as I take it, of Sir George's interesting paper, is that a process of printing has been employed for ages, but that its use for literary purposes was a casual and later application.

HYDE CLARKE.

General Notes.

ODESSA EXHIBITION.—The *Journal de la Chambre de Commerce de Constantinople* announces that the Russian Government has recently decided to hold a grand national Exhibition at Odessa, with the object of developing the Balkan trade, the chief outlet for which is the port of Odessa. It is also decided to make the products of Russian commerce known and appreciated by the Slav populations of the Balkans. This Exhibition will be held at the time of the centenary *fêtes* of the town of Odessa, which are to take place in 1894.

RUSSIAN AND AMERICAN OIL IN INDIA.—The total kerosene imported into Bombay in 1889-90 was 13,704,072 gallons, against 11,930,739 gallons in 1888-89. Of this amount 10,742,344 gallons came from Batoum, and only 2,961,728 gallons from the United States, or, respectively, 77 and 23 per cent. Four years ago, only 1,481,232 gallons came from Russia, and 5,871,588 gallons from the United States, or, respectively, 20 and 80 per cent.; so that, in four years, the positions of the United States and Russia in the Indian oil trade have been practically reversed.—*Board of Trade Journal*.

Journal of the Society of Arts.

No. 2,026. VOL. XXXIX.

FRIDAY, SEPTEMBER 18, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

"OWEN JONES" PRIZES.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the School of Art who, in annual competition, produce the best design for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates:—

Gertrude Roots, School of Art, Canterbury.—Design for a mosaic pavement, and design for a plate.

Edith Gillman, School of Art, Canterbury.—Design for a damask table-cloth.

Evelyn D. Foster, School of Art, Hertford.—Design for a mosaic floor decoration.

Annie Barnett, School of Art, Cavendish-street, Manchester.—Design for a majolica plate.

Arthur Beardsley, School of Art, Nottingham.—Design for an Axminster carpet.

William Rawlinson, School of Art, Burnley.—Design for a printed cotton hanging.

The next award will be made in 1892, when six prizes will be offered for competition.

FOTHERGILL PRIZE.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire.

A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres or other places of public amusement.

In cases where the Invention is in actual use, reference should be made to places where it could be inspected.

A full description of the Invention, accompanied by such drawings or models as are necessary for its elucidation, must be sent in on or before the 31st December, 1891, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding the Prize, in case there is nothing in their opinion deserving the award, or sufficiently complying with the conditions sent in for competition.

Chicago Exhibition, 1893.

The United States government regulations governing the free importation of articles for exhibition at the World's Columbian Exposition at Chicago, in the year 1893, which have been published by the Director-General, are as follows:—

Treasury Department, Office of the Secretary,
Washington, D. C., January 7, 1891.

To Collectors of Customs and Others:

Section 11 of the Act of Congress, approved April 25, 1890, providing for celebrating the four hundredth anniversary of the discovery of America by Christopher Columbus, by holding an international exhibition of arts, industries, manufactures and the product of the soil, mines, and sea, in the City of Chicago, in the State of Illinois, is as follows, viz.:—

"That all articles which shall be imported from foreign countries for the sole purpose of exhibition at said Exposition, upon which there shall be a tariff or customs duty, shall be admitted free of payment of duty, customs fees, or charges, under such regulations as the Secretary of the Treasury shall prescribe; but it shall be lawful at any time during the Exhibition to sell for delivery at the close of the Exposition buildings or on its grounds, subject to such regulations for the security of the revenue, and for the collection of the import duties as the Secretary of the Treasury shall prescribe: *Provided,*

That all such articles, when sold or withdrawn for consumption in the United States, shall be subject to the duty, if any, imposed upon such articles by the revenue laws in force at the date of importation, and all penalties prescribed by the law shall be applied and enforced against such articles, and against the persons who may be guilty of any illegal sale or withdrawal."

Under the authority conferred by said provision of law, the following regulations are hereby prescribed, viz. :—

1. No duty, fees, or charges for customs service will be exacted on any such importations, except where the merchandise is subject for consumption in the United States, and entered as provided by these regulations.

Goods destined for such Exhibition may be imported through any port of entry.

2. Invoices showing the marks, numbers, character, quantity, and foreign market value of articles intended for such Exhibition shall be made in triplicate, and one copy forwarded to the collector of customs for the port at which it is intended such articles shall enter the United States, one copy to the Collector of Customs for the port of Chicago, and one copy to the consignee or agent of the shipper. The shipper of such goods may declare to the invoice as the agent of the exhibitor, and the invoice shall be authenticated by one of the Commissioners for the Exhibition, appointed by the Government of the country from which the goods are exported, or by a United States Consul, at the election of the party declaring to such invoice. Articles intended for exhibition which are government property, used solely for government purposes, and not intended for sale in this country, will be admitted to entry upon a certificate to that effect by the Commissioner for the International Exhibition of the Government to which such property belongs.

3. All packages containing such articles must be plainly addressed to the Collector of Customs, Chicago, U.S.A., and conspicuously marked "Exhibits for the World's Columbian Exposition," and also bear the names and addresses of the shipper and consignee, and appropriate invoice marks and numbers.

4. Upon the arrival at any port of entry of packages so marked and containing articles intended for such Exposition, entry thereof, in form to be prescribed, may be made by the consignee or agent thereof, for immediate transportation, without appraisalment, to Chicago.

5. Upon the arrival of the cars containing such articles at Chicago, the conductor or agent of the railroad company will report such arrival by the presentation of the manifest to the customs officer designated to receive such manifests, who shall compare the same with the copy received by mail, and superintend the opening of the cars, taking care to identify the packages by marks and numbers as described in the manifests.

In case of the non-receipt of the manifests, the un-

loading of the cars shall not, for that reason, be delayed, but the invoice will be used to identify the packages.

When such articles arrive at Chicago by vessel direct from a foreign country, a special entry for warehouse, in the manner hereinbefore provided, may be made, whereupon a special permit will be issued for the transfer of the articles from the importing vessel to the Exposition buildings.

The packages will be retained in the custody of the customs officers, unopened, until special entry for warehouse, in form to be prescribed, is made by the owner, consignee, or agent authorised to make entry, but no warehousing bond will be required.

6. Upon the completion of the special warehouse entry, the packages will be opened and due examination and appraisalment of the contents will be made by the appraiser at the Exhibition buildings, which shall, for that purpose, be regarded as a public store. The appraiser will be furnished with the invoice of the articles to be appraised, and will indorse his report of appraisalment upon such invoice in like manner as if such articles were regularly entered for consumption or warehouse. The entry will then be liquidated, the full amount of duties ascertained, and the whole transaction entered upon a record to be kept in the form of a special warehouse ledger.

7. The articles may then be placed in the position provided for their exhibition, but will remain under the custody and control of the customs officers, and will not be removed from the place assigned without a permit from the Collector of Customs or the officer who may be designated to grant such permit. In no case will such articles be removed from the Exposition building, or released from the custody of the customs officers, unless the same shall have been regularly entered for withdrawal for consumption, warehouse, or export.

8. In case of exportation of such articles, existing regulations requiring exports to be made in original packages will be waived.

9. The special forms of entries, permits, manifests, and records to be used under these regulations will be prepared and furnished by the Treasury Department.

10. Collectors of Customs will report to the Secretary of the Treasury any case relating to an importation for such Exposition in which they may regard these regulations as insufficient to secure the interest of the revenue, and special instructions will be given for their guidance in such case.

11. In the event of the loss—by theft, or otherwise—of articles entered for exhibition, the importer or owner will be responsible, primarily, for the duties thereon; but, on a proper representation of the facts in writing to this Department, payment of the duties will be waived, if the circumstances appear to justify such action.

12. The deterioration of perishable goods, and the consumption of articles as samples during the Exhibition, will be made the subject of special con-

sideration by this Department, with a view to the relief of the owner from the payment of duties, on the receipt of a report from the Collector of Customs at Chicago establishing the facts.

13. Show-cases will be admitted free, as accessories to the Exhibition; but, if sold, will be subject to duty.

14. If a difference be found to exist in the quantity of goods entered at the custom-house and that eventually reported or withdrawn at the close of the Exposition, action will be taken as mentioned in paragraph 12. It is not contemplated that duties shall be levied, except on goods which have actually entered into consumption in this country.

WILLIAM WINDOM,
Secretary.

GENERAL REGULATIONS FOR FOREIGN EXHIBITORS.

1. The Exhibition will be held on the shore of Lake Michigan, in the City of Chicago, and will be opened on the 1st day of May, 1893, and closed on the 30th day of October following.

2. All Governments have been invited to appoint commissions for the purpose of organising their departments of the Exhibition. The Director-General should be notified of the appointment of such foreign commissions as soon as the appointment is made.

Diagrams of the buildings and grounds will be furnished to the foreign commissions on or before January 1, 1892, indicating the localities to be occupied by each nation, subject, however to revision and readjustment.

3. Applications for space and negotiations relative thereto must be conducted with the commission of the country where the article is produced.

4. Foreign commissions are requested to notify the Director-General not later than June 1, 1892, whether they desire any increase or diminution of space offered them, and the amount.

5. Before November 1, 1892, the foreign commissions must furnish the Director-General with approximate plans, showing the manner of allotting the space assigned them, and also with lists of their exhibitors, and other information necessary for the preparation of the official catalogue.

Products brought into the United States at the ports of Portland, Maine, Boston, New York, Philadelphia, Baltimore, Tampa, New Orleans, San Francisco, Wilmington, Portland, Oregon, Port Townsend, Wash., Seattle, Wash., Tacoma, Wash., and Chicago, Ill., or at any other port of entry, intended for display at the International Exhibition, will be allowed to go forward to the Exhibition buildings, under proper supervision of customs officers, without examination at such ports of original entry, and, at the close of the Exhibition, will be allowed to go forward to the port from which they are to be exported. No duties will be levied upon such goods, unless entered for consumption in the United States.

6. The transportation, receiving, unpacking, and arranging of the products for exhibition will be at the expense of the exhibitor.

7. The installation of heavy articles requiring special foundations or adjustment should, by special arrangement, begin as soon as the progress of the work upon the building will permit. The general reception of articles at the Exhibition buildings will commence on November 1, 1892, and no articles will be admitted after April 10, 1893.

8. Space assigned to foreign commissions, and not occupied on the 10th day of April, 1893, will revert to the Director-General for reassignment.

9. If products are intended for competition, it must be so stated by the exhibitor; if not, they will be excluded from the examination by the international juries.

10. An Official Catalogue will be published in English, French, German, and Spanish. The sale of catalogues is reserved to the World's Columbian Exposition.

The twelve departments of the classification which will determine the relative location of articles in the Exhibition—except in such collective exhibits as may receive special sanction—also the arrangement of names in the catalogue, are as follows:—

- A. Agriculture, Forest Products, Forestry, Machinery and Appliances.
- B. Viticulture, Horticulture, Floriculture.
- C. Live Stock: Domestic and Wild Animals.
- D. Fish, Fisheries, Fish Products, and Apparatus for Fishing.
- E. Mines, Mining, and Metallurgy.
- F. Machinery.
- G. Transportation: Railways, Vessels, Vehicles.
- H. Manufactures.
- J. Electricity.
- K. Fine Arts: Pictorial, Plastic, and Decorative.
- L. Liberal Arts: Education, Engineering, Public Works, Architecture, Music, and the Drama.
- M. Ethnology, Archæology, Progress of Labour and Invention, Isolated and Collective Exhibits.

11. Foreign commissions may publish catalogues of their respective sections.

12. Exhibitors will not be charged for space.

A limited quantity of steam and water power will be supplied gratuitously. The quantity of each will be settled definitely at the time of the allotment of space. Any power required by the exhibitor in excess of that allowed will be furnished by the World's Columbian Exposition at a fixed price. Demands for such excess of power must also be settled at the time of the allotment of space.

13. Exhibitors must provide, at their own cost, all show-cases, shelving, counters, fittings, &c., which they may require, and all countershafts, with their pulleys, belting, &c., for the transmission of power from the main shafts in the building where the exhibit is located. All arrangements of articles and

decorations must be in conformity with the general plan adopted by the Director-General.

NOTE.—The general plan requires all decorations, signs, &c., to be in harmony with the dignity and magnitude of a magnificent Exhibition, and the Director-General is empowered to secure this result.

The World's Columbian Exposition will take precautions for the safe preservation of all objects in the Exhibition, but it will in no way be responsible for damage or loss of any kind, or for accidents by fire or otherwise, however originating.

NOTE.—A thoroughly equipped fire department will protect the buildings and exhibits, and a large police force will maintain order. The entire Exposition grounds will be under the immediate supervision of the City of Chicago and of the State of Illinois. A guard, equal to any possible contingency, is thus provided, the municipal authority being upheld, if necessary, by the State troops, and the State by the army of the United States, so that no apprehension need arise as to losses resulting from lawlessness.

14. Favourable facilities will be arranged by which exhibitors or foreign commissions may insure their own goods.

NOTE.—Special care has been taken to render everything about the Exposition as nearly fire-proof as possible; and it is reasonably certain that the rates of insurance will not be excessive, but, on the contrary, very reasonable. Exhibitors may insure in any company, foreign or domestic. Arrangements will be made with English, French, German, and American companies to fix uniform or special rates on exhibits and buildings; so that no advantage will be taken of any exhibitor who wishes to insure his goods.

Foreign commissions may employ watchmen of their own choice to guard their goods during the hours the Exposition is open to the public, subject to the rules and regulations of the Exposition.

15. Foreign commissions, or such agents as they may designate, shall be responsible for the receiving, unpacking, and arrangement of objects, as well as for the removal at the close of the Exposition; but no person shall be permitted to act as such agent until he can give to the Director-General written evidence of his having been approved by the proper commission.

16. Each package must be addressed "To the Commission (name of country) at the World's Columbian Exposition, Chicago, United States of America," and should have at least two labels affixed to different, but not opposite, sides of each case, and give the following information:

17. (1) The country from which it comes; (2) name of firm of the exhibitor; (3) residence of the exhibitor; (4) department to which objects belong; (5) total number of packages sent by that exhibitor; (6) serial number of that particular package.

18. Within each package should be a list of all objects.

19. If no authorised person is at hand to receive goods on their arrival at the Exposition buildings,

they will be removed without delay, and stored at the risk and cost of whomsoever it may concern.

20. Articles that are in any way dangerous or offensive, also patent nostrums and empirical preparations, whose ingredients are concealed, will not be admitted.

21. The removal of goods on exhibition will not be permitted prior to the close of the Exhibition.

NOTE.—Articles not on exhibition for competition may be sold under special permit.

22. Sketches, drawings, photographs, or other reproductions of articles exhibited will only be allowed upon the joint assent of the exhibitor and the Director-General; but views of portions of the building may be made upon the Director-General's sanction.

23. Immediately after the close of the Exhibition exhibitors shall remove their effects, and complete such removal before January 1, 1894; goods then remaining will be removed and sold for expenses, or otherwise disposed of under the direction of the World's Columbian Exposition.

24. Each person who becomes an exhibitor thereby acknowledges and agrees to be governed by the rules and regulations established for the government of the Exhibition.

Special regulations will be issued concerning the exhibition of fine arts, awards, the organisation of the international juries, and sales of special articles within the buildings, and on other points not touched upon in these preliminary instructions.

25. All communications concerning the Exhibition will be addressed to the Director-General, World's Columbian Exposition, Chicago, Illinois, U.S.A.

The management reserves the right to explain or amend these regulations, whenever it may be deemed necessary for the interest of the Exhibition.

GEORGE R. DAVIS,
Director-General.

WALKER FEARN,
Chief Department of Foreign Affairs.

Miscellaneous.

JETHRO TULL.

Jethro Tull, the father of modern husbandry, died in 1741, thirteen years before the formation of the Society of Arts; and one of the first works which the Society set itself to do was the spreading abroad of a knowledge of the advantages of that system of drill culture which he had introduced. Robert Dossie, in his *Memoirs of Agriculture* (1768), writes as follows:—"It is not pertinent to the subject here to enter into the dispute where and by whom the method of drill culture was first invented; but it is an unquestionable truth that Mr. Tull, who wrote largely on this kind

of husbandry, was the first who introduced the use of it into our country. He nevertheless only started the notion. The practice was very little pursued till the Society awakened the public attention to it by their premiums."

This great benefactor of the human race has been forgotten by the great majority of his countrymen, and it is only two years ago that Mr. Walter Money discovered the place of his burial. Tull's claims to honour, and the neglect into which his memory was allowed to sink, are well set forth by Dr. Johnson in a few words. He said:—"His grave is undetermined. If he died at Shalbourne there is no trace of his burial in the parish register. The tradition of the neighbourhood is that he died and was buried in Italy. His deeds, his triumphs, were of the peaceful kind, with which the world in general is little enamoured; but their results were momentous to his native land. His drill has saved to it, in seeds alone, the food of millions, and his horse-hoe system, by which he attempted to cultivate without manure, taught the farmer that deep ploughing and pulverisation of the soil render a much smaller application of fertilisers necessary."

Justice has at length been done to the memory of this great man, and Earl Cathcart has contributed to the *Journal of the Royal Agricultural Society* (3rd series, vol 2, p. 1), an article on "Jethro Tull: his life, times, and teaching," in which he quotes largely from the diary of Charles, 8th Lord Cathcart, who was a friend and disciple of Tull. The article is also illustrated by an engraving from a contemporary portrait of Tull. The following particulars are extracted from the pages of the Royal Agricultural Society.

Lord Cathcart commences his article with these words:—"The world forgets so much and remembers so little. Until the other day Tull's grave was undiscovered, and even now no storied urn, no monumental brass, marks the modest grave of a man so worthy of honour. Yet more remarkable still is the fact that, although the student reads the name of Tull 'writ large' on the face of every arable field in Great Britain, and over all the world wherever British agriculture is known and prevails, the ordinary reader—and such is fame!—will say to himself, Who is this man? When did he live? and What did he do?" Lord Cathcart answers these questions thus:—"Jethro Tull, in the early years of the reign of King George the Second, wrote a book entitled, *The Horse-Hoeing Husbandry, or a Treatise on the Principles of Tillage and Vegetation, wherein is taught a method of introducing a sort of Vineyard Culture into the Cornfields, in order to increase their product and diminish the common expense*. The principles formulated in this famous book, ultimately—but step by step and by very slow degrees—revolutionised British agriculture. Tull invented the drill; but our admiration and gratitude are chiefly due to him because of the reasons which he gave us for the

utility of his undoubted invention of that now universally employed implement."

A personal friend and neighbour wrote, some years after Tull's death, that he "was the first Englishman—perhaps the first writer, ancient and modern—who has attempted, with any tolerable degree of success, to reduce the art of agriculture to certain and uniform principles; and it must be acknowledged that he has done more towards establishing a rational and practical method of husbandry than all the writers who have gone before him." Yet Tull did not pride himself on his skill as an author, for he wrote, "Writing and ploughing are two different talents; and he that writes well must have spent in his study that time which is necessary to be spent in the fields by him who will be master of the art of cultivating them."

Arthur Young visited Tull's farm, and affirmed that his work would carry his name to the latest posterity. Cobbett, who was equally enthusiastic, wrote:—"I was born and bred amongst affairs of gardening and farming, and I was well read, but till I read Tull I knew nothing of principles. Here are in fact all the whole codes of the principles of vegetation and of general application, whether in the cornfields, the pastures, the gardens, the coppices, the woods, and the forests."

This man, who did so much, was, however, no mere husbandman, for he was an excellent mechanic, a musician, and a classical scholar of no inconsiderable attainments. Moreover, his work was done under circumstances of peculiar difficulty; for his whole life was one long struggle with chronic disease. Jethro Tull, the heir to a competent paternal estate, was born at Basildon, in Berkshire, in 1674, and at the age of 17 years, matriculated at St. John's College, Oxford. He was a student of Gray's-inn in 1693, and was called to the bar on May 19, 1699. Mr. Joseph Foster states that he became a bench of his inn on May 5, 1724. He intended to enter public life, previous to which he made the "grand tour;" but, on his return, circumstances changed his purposes, and he devoted himself to agriculture.

In 1669, Worlidge produced a drawing of a theoretical drill; but he did nothing more than make a woodcut of it. Dr. Bradley spent £25 in making an instrument from the cut; but when it was made it would not work. Tull invented his drill about the year 1701, and he thus describes his discovery:—"My diversion in youth was music. I understood the mechanism of my organ. Plough servants began to exact their dominion over their masters, and a gentleman farmer could make little profit of arable land; mine being of that sort, I resolved to plant my whole farm with sainfoin. Seed was scarce, dear, and bad, and enough could scarce be got to sow, as was usual, seven bushels to an acre. I examined and thought the matter out, and found the greater part of the seed miscarried, being bad, or too much covered, or too little covered. I observed, and counted, and found, when much seed had miscarried,

the crop was the best. Then I learned to distinguish good seed from bad, and, by many trials, found in my strong land that the best seed could not succeed unless covered at a certain exact depth; and I discovered the reason of this nicety. So I caused channels to be made, and sowed a very small proportion of seed, covered exactly. This was a great success." The labourers disliked Tull's innovations, and struck against them. They were dismissed, and Tull set to work to invent an implement to improve upon human labour. He wrote, "I resolved to quit my scheme, unless I could contrive an engine to plant sainfoin more faithfully than hands would do. I thought, and examined all the mechanical ideas that had ever entered my imagination, and at last pitched upon the groove, tongue, and spring in the soundboard of the organ. With these a little altered, and some parts of two other instruments, as foreign to the farm as the organ, I composed my machine. The first seed-box was worked on the iron gudgeon of a wheelbarrow, with a brush-harrow to cover the seed."

Trouble with his men, the attacks of enemies in the outer world, his anxieties and bodily labours, completely broke down his health, and he was forced to seek a milder climate in France and Italy. He himself wrote, "I travelled in April, 1711, being above 10 years after making and using my drill. . . I was obliged to travel for saving my life." Though travelling to recruit his bodily powers, his mind was as active as ever, and he tells us himself that he was thinking out the great work of his life. "I took the first hint of my horse-hoeing culture from the ploughed vineyards near Frontignan and Setts in Languedoc, a southern province of France, on the Mediterranean. After my return to England I improved these hints by observing that the same sort of vineyard tillage bestowed on potatoes and turnips had the same effect on them as it had on their vines. So also in regard to corn. I was thus confirmed in the principles which, by arguing from effects to their causes, I had formed to myself, and my practice ever since has been a further confirmation of the truth of the same principles." It was not, however, until 1731 that the first instalment of the great work on horse-hoeing husbandry was issued. It was entitled "*Specimen of a Work on Horse-hoeing Husbandry*," and at once attracted considerable attention. Some of this attention was unwelcome, for it consisted of the pirating of the book in Ireland, where it was reprinted without acknowledgment. Tull was so much disgusted that he came "to a resolution to publish no more." Influential friends protested against this resolution, and he was induced to reconsider it. With respect to the evidences of this pressure, Lord Cathcart writes: "They show the impression made at the time on highly-placed persons, men of the world who knew Tull personally and intimately, soldiers and courtiers, who had no sort of motive to flatter or exaggerate. Obviously they liked Tull personally, they considered his health

and life of public importance, they regarded him as labouring for his country's benefit, and looked upon him as a public benefactor." The work entitled "*New Horse-hoeing Husbandry*" was published in 1733, with a supplement in 1739. Other editions appeared in 1739, 1751, 1753, 1762, and 1772. It was translated into French by Duhamel, and subsequently into most of the European languages. New editions of the original were published by Cobbett in 1822 and 1829. Queen Caroline headed the list of subscribers to the book, and Tull wrote:—"The reason there is no dedication to my essay is this: the Queen having done me the honour to subscribe to my book, I could not dedicate it to any other person, and her Majesty's royal virtues being too far above any panegyric I was able to write, I chose rather to leave it to the protection of the royal license and laws."

Tull was careful in the use of manure, and he was widely attacked on this point, attacks which he felt very keenly. He says himself:—"The vulgar in general believe that I carried my farm-yard dung and threw it in a river. I have no river near; besides, my neighbours buy dung at a good price; but it is known I neither sell nor waste any dung. Against such lying tongues there is no defence." Respecting this, Sir John Lawes wrote to Lord Cathcart:—"Tull is quite an original genius, and a century in advance of his time. I consider he has been most unjustly accused of not placing sufficient value upon farm-yard manure; he advocated cleanliness, and saw that dung was a great carrier of weeds. To give some clear idea of the value of Tull's advocacy of drill husbandry, and the freedom from weed which can alone be obtained by the use of the drill, I may mention that, so far as statistics will allow, I have ascertained the average yield of the wheat crop of the world, and I am able to say that the average yield is less than it is at the present time upon my permanent wheat land after more than sixty years absolutely without manure. Here we have the result of Tull's three great principles—drilling, reduction of seed, and absence of weed. If he were alive now, and were writing for the agriculture of the world, he would, I think, be quite justified in saying everything he said in regard to cleanliness and manure."

Although several great landowners were followers of Tull, his ideas were not at first accepted in England; and Loudon records that the Scotch farmers were the first to discover the merits of Tull's system. From Scotland the improved husbandry was introduced into Northumberland, in 1780, and it gradually worked its way downwards.

Tull's infirmities increased with his age, and six years before his death he was confined to his house, and unable to visit his fields. He was a disappointed man, and when his friends spoke of the glory of his achievements, he said:—"Glory is the reward of warriors, attained on the field of battle; but in our

arable fields, the master of them must be a slave to those people who are under the greatest obligation to serve him; and slavery is opposite to victory." He died in March, 1740-41, at the age of sixty-six years, and in spite of disappointments and abuse, which he keenly felt, he died in the faith that his system would ultimately triumph and become general.

The late Mr. Cuthbert Johnson, F.R.S., who collected a large amount of materials of importance connected with Tull, offered a reward for the discovery of his grave, but in vain. In 1889, Mr. Walter Money made the discovery in the parish registers of Basildon, Berks, where he found this entry:—"Jethro Tull, Gentleman, of the Parish of Shalbourne, in the County of Berks, was buried March ye 9th, 1740[-41]."

Basildon is twenty miles as the crow flies from Prosperous Farm and Shalbourne, and the reason why he was buried so far from his home must be found in his desire to be laid at rest where he first saw the light.

PUBLIC LIGHTING IN EASTERN EUROPE.

The French Government having desired its Consuls in the principal towns of the east of Europe to report on the public lighting of those places, the representatives of France have furnished particulars on that subject, which are published in the *Moniteur Officiel du Commerce* for July 9th and 16th. According to these reports it appears that there exists no manufactory of lighting apparatus in Roumania, with the exception of one recently founded in Bucharest, and this, at present, does no more than produce wick-holders for petroleum lamps; the cylindrical glasses for the same are principally made at the glass-works of Azuga. It is intended to make lamps in the Bucharest factory, and before very long it is probable that the whole apparatus for lighting with petroleum will be manufactured at least at one place in Roumania. With the exception of certain small accessories, everything connected with lighting by means of gas has to be imported into Roumania from abroad. Most of the lamps now used in that country are furnished by makers in Austria-Hungary, mainly from Vienna and from Buda Pesth. Lamps are also imported, but in much smaller quantities, from Germany.

There is no gas used in any town of Roumania except Bucharest. Everywhere else simple petroleum lamps are used, and the town of Galatz is lighted by 1,695 of these. At Jassy the theatre and the circus have lamps of vegetable oil, but everywhere else petroleum only is used in glass lamps with a straight wick. For domestic lighting lamps of all dimensions are used, with burners and circular wicks, all which lamps are imported from Austria or Germany.

When we turn to Servia, we find that Belgrade, the capital, contains no manufacturer of illuminating

apparatus. The streets are lighted by a few petroleum lamps with reflectors, and when the municipality has need of a supply of lanterns, it applies to the Jewish tinmen, who produce what is required. Nisch is lighted only by petroleum lamps at certain important points of the town; and there is not even a shop devoted to lighting or lamps: the latter are ordered from Vienna or Buda Pesth, and sold by grocers or dealers in hardware.

In Sofia, the capital of Bulgaria, there are several dealers in lighting apparatus, but there is no manufacturer of these articles in any part of Bulgaria. What is used comes exclusively from abroad, and principally from Bohemia. There is a small importation of glass lamps from Belgium. No other substance than petroleum is used in any part of the country. Lighting apparatus only figures in the Bulgarian trade reports under the head of "Glass manufactures." The figures of the import value of these articles, in 1889, was £5,400. In Varna, as in Sofia, petroleum alone is used for lighting. The favourite form of lamp is a cheap suspended lamp, with a single burner. There is a great sale at Varna of small lamps, specially introduced for the little towns and villages of the interior. These are made of glass, and cost about 18s. a hundred.

In European Turkey little is used except petroleum. Even in the public offices of Constantinople, into which gas had been introduced, it has been found so bad and so expensive that it has for the greater part been rejected, and petroleum once more taken into use. In private houses, as in shops, *cafés*, and restaurants, nothing is now used but the large petroleum lamps. The electric light is employed only in the palace of Yildiz, it being forbidden by law to use it elsewhere. The supply of lamps for Constantinople is almost entirely in the hands of Austrian and German merchants. The kinds which they supply are usually of second-rate or even inferior quality, cheapness being an essential matter. The natives are in the habit of calling petroleum gas, even when they are speaking French, but it is important to understand that they always mean petroleum. There are three French shops in Pera, and an Austrian house in Stamboul where lamps of a better quality may be bought.

At Adrianople no gas is manufactured, and an attempt which was lately made to illuminate the city with the electric light was a complete failure. The only material used is petroleum, which is imported from the Russian establishments at Batoum. The city is lighted by very cheap lamps on a most imperfect system, consisting merely of a cylindrical box of tin-plate, scarcely eight centimetres high, and priced at from 8d. to 9d. each. The inside of certain establishments, such as the *cafés* and hotels, is lighted by lamps of a more elaborate description, from Austria or Germany. Austria inundates the country with a cheap article, devoid of all solidity of construction, but sufficient to satisfy the requirements of the Turks.

The only product employed for lighting purposes in the island of Crete, except candles, is Russian petroleum oil, of very bad quality, and dispersing a disgusting odour. The lamps are generally very common, but cheap. Most of them possess a glass reservoir, mounted on a stand in porcelain or metal. These are imported from Austria. No manufacturer of lighting apparatus exists in Eastern Roumelia. Petroleum lamps are used, and these can only be purchased in the capital, Philippopolis. At Bourgas, the chief port of Roumelia, all lighting apparatus has to be brought from Constantinople.

Oil is but very little used for lighting in Salonica, and, consequently, there is no sale for articles intended for this species of illumination. Gasworks have recently been set up in Salonica, but, hitherto, the number of consumers is very small. Petroleum is almost exclusively used throughout the town, and there is a considerable market for apparatus used in this kind of lighting, portable lamps of all sorts, with glass, porcelain, &c. All these articles are of Austrian manufacture, and of inferior quality, but find a ready sale, on account of their cheapness. A Paris house attempted, some time ago, to introduce in Salonica lamps of its manufacture, but they were not bought, as they were too expensive. A manufacturer who wishes to sell his lamps in this town ought, first of all, to obtain information as to the price at which similar articles are at present sold there.

The only form of illumination which is employed in Albania is petroleum lamps, the importation of which reaches a value of £500 or £600 a year. None are manufactured in the country, even at Janina, Scutari, or Durazzo, but are manufactured in Austria and introduced from Trieste to ports along the Albanian coast, and sold in the bazaars. In Bosnia-Herzegovina, also, gas and oil are totally unknown as illuminants, and the whole country depends on the importation of cheap petroleum lamps from Austria.

In Greece, gas is used in the towns of Athens and Corfu. In the former everything connected with lighting by gas is supplied by a French company on the spot; in Corfu the apparatus has to be imported from an English gas company at Malta. In the rest of the country lighting is almost exclusively performed by means of petroleum lamps of Austrian or German manufacture. At Syra there exists no person who regularly sells lighting apparatus of any description, but very bad porcelain or metal lamps may sometimes be picked up at the china or tin-shops. There was once a proposal that Syra should be lighted with the electric light, but the poverty of the municipality and political reasons combined to prevent it.

Mr. T. B. Sandwith, Her Majesty's Consul-General at Odessa, writing to the Foreign-office, under date of the 1st August, says that the port of Odessa, in contradistinction to the town of that name, having, for many years, remained unlit, even by oil lamps, and, within two years only, being lit by

gas, has at length been illuminated by electricity. An installation has been completed, at a cost of 80,000 roubles (£8,400). This consists of 64 arc lamps, of 2,000 candle-power each, and of two lanterns, one at each end of the breakwater, which runs the whole length of the port. The illuminating power is generated by two of Wilson's vertical engines, of 67 horse-power each.

The Odessa town council has just assigned a sum of 20,000 roubles (£2,100) annually for the working expenses.

The new installation is a great boon to the shipping interest, the whole of the port being brilliantly lighted up, so as to admit of the loading and discharging of steamers by night.—*Board of Trade Journal*.

THE MINES OF NEW CALEDONIA.

The French *Moniteur Officiel du Commerce* says that for some considerable time past attention has been directed to the mineral wealth of the soil of New Caledonia. This colony, from a geological point of view, may be divided into three regions—a serpentine formation constituting the principal part of the island, crystalline earth in the north and north-east, and metamorphic beds in the west and south-west. The serpentine region occupies the entire breadth of the island, from the southern extremity to about the centre, with the exception of a belt stretching the length of the west coast to the foot of Mont d'Or, and certain belts of crystalline earth running the whole length of the island. Gold, copper, antimony, and lead are found chiefly in the north of the island. Towards the west, coal is found, and, in this district, various descriptions of limestone, slate, and gypsum are also found. Nickel ore was discovered for the first time in New Caledonia in 1867, and in 1873 its presence was signalled at Mont d'Or, near Boulari. Since that time, the workings of the nickel, cobalt, and chrome mines have undergone considerable development, and permit of an accurate account being kept of the production and resources of each description of bed. There is no sulphuretted nickel found in New Caledonia, such as is met with in Sweden, Norway, and in the Italian Alps, and yet the rocks in which this metal is found are identical with those in the latter places. Pure samples of nickel ore have been found to be composed as follows:—Nickel 26, magnesia 13, iron 3, silica 45, and water 13 parts. This is an exceptional result, as, generally, the ores contain, after manipulation, from 7 to 12 per cent. of nickel. Nickel ore is found almost exclusively in the bed of the serpentine formation, and always in contact with, or in the neighbourhood of, red clay—never, however, in the clay itself. From a mining point of view, little appears yet to be known of certain parts of New Caledonia, but on the coast alone there is said to be an almost inexhaustible quantity of nickel. On the 1st January, 1890, the

number of nickel mines was 115, representing an area of 27,785 acres. The most important nickel district is that of Thio, and since 1876, the date at which the first workings were commenced, up to the year 1890, from the mines in this district alone, 59,448 tons of ore were exported. Beyond the district of Thio, important workings have been commenced in the neighbourhood of Nakety, of Kanoua, and on the west coast in the district of Tontouta. The proprietors of the various nickel mines of New Caledonia have, it is said, the greatest confidence in the future of these workings, and are sparing no effort to develop the industry, more especially as there appears at the present time to be a very great demand for this product. Chrome ore is found in considerable quantities in the serpentine formation of New Caledonia. The chrome beds are of two kinds—either in veins or in stratified beds in clay basins. The first application for permission to work this product was made in 1875, but since then important discoveries have been made, principally in the districts of Mont d'Or, Plum, and Pirogues bay. The most important workings of chrome are those of the river N'Go and the Pirogues river, which are connected with the sea by railways. From seven of the workings in these districts alone, over 2,250 tons of chrome ore were exported in 1889. Cobalt ore, as well as chrome ore, is found in very considerable quantities throughout the serpentine formation of New Caledonia. This ore is associated with manganese, and is found in the form of beds or deposits on the borders of the clay basins which, in a great number of places, traverse the serpentine formation. The cobalt ores, after manipulation, only contain from 3 to 5 per cent. of oxide of cobalt. The first application for permission to work cobalt dates from 1876; but since then many discoveries have been made, principally in the districts of Ouen, Unia, Nehoué, and in the islands of Yandé, Belep, &c. The most important workings are in the districts of Nakety, Laugier Bay, Uqué Bay, Mou, Wagap, and the islands of Yandé and Belep; and others have been commenced in the neighbourhood of Goyeta and Oland Bay; and, as the New Caledonian product is said to be in great demand in the markets of Europe and Australia, great efforts are being made to develop this industry. Formerly, this ore was obtained from certain mines in Saxony and Norway, and these give only from 1 to 2 per cent. of cobalt. At the present day, in New Caledonia, they yield from 3 to 5 per cent. The district of Diahot, which is watered by the river of that name, is beginning to attract the attention of miners, owing to the quantities of gold, copper, and argentiferous lead which are found there. It was in 1870 that gold was first discovered, in a place called Maughine, on the left bank of the Diahot; and, in the same year, permission was given to work a district of about 60 acres in extent. This working yielded satisfactory results; and, from 1870 to 1873, 4,663 ounces of gold were obtained, representing a value of £17,775. Numerous discoveries

of gold have been made in the north of the island; but on nearly all parts of the island the works have been abandoned, owing to the absence of capital; and this, it is said, is the more to be regretted, as the veins found appear to indicate the presence of a wealth of gold greater than that actually yielded in Australia. The presence of copper was discovered for the first time at the end of the year 1872, in the river Ouegoa, near the village of that name. In 1884, croppings of considerable richness were discovered near Pam, in the district of Arama, to the north-west of the mouth of the Diahot. The Nemou mine, situated in this district, has a vein of copper, exceedingly thick; and croppings of this vein appear in a ravine situated to the east of Mount Pouap, at the bottom of which an enormous block of copper, weighing about five tons, was discovered. This was exhibited at the Paris Exhibition of 1889. Working was commenced here in 1886, and from that year up to January, 1890, a quantity of ore was obtained, amounting to about 23,500 tons, of which about 2,323 tons were exported to England and Australia. Argentiferous lead was first found in 1881, on the left bank of the Diahot; and, at the Meretrice mine, at the present day, indications point to the existence of rich viens. Unfortunately, the want of capital has also stood in the way of the development of the workings of this product. Antimony is found in the district of Nakety; and it is stated that considerable quantities will be found in other parts of the island. The ore which is the most abundant in New Caledonia is iron ore. It accompanies nickel, chrome, and cobalt, and is found under similar geological conditions, with this difference, that it is found in much greater quantities. According to the opinion of competent persons who have visited the principal iron ore districts of Europe, in no place is it found in such abundance as in New Caledonia. There it is not in veins or beds, but exists in vast masses. Coal, again, is known to exist in vast quantities, principally on the west coast of New Caledonia. Croppings are apparent at the foot of Mont d'Or, on the shores of Boulari Bay, in the plain of Saint Louis, and in the neighbourhood of Noumea. They are found also at Koutio-Koueta, at Dumbea, Moindon, and Voh, in fact, all over the west coast. These coal beds are now attracting particular attention in New Caledonia. Trials have been made of the Noumea coal on board various steamships; and they have shown that it is at least equal to the best Australian coal, with the advantage of giving off less smoke. In the coal basins of Ouvail and Moindon eight beds have been found, with a thickness of from eight to twelve yards; and the most satisfactory results are anticipated from these discoveries. In addition to the mineral wealth above mentioned, there have been found, in different parts of the colony, manganese, iron pyrites, marble, and lithographic stone. Traces have also been discovered of mercury, tin, platinum, and immense deposits of kaolin and gypsum.

INCREASE OF FARM ANIMALS IN THE UNITED STATES.

One of the last bulletins issued from the United States Census-office deals with the statistics of horses, mules, and asses on farms in the United States. The figures refer to animals on farms of three or more acres in extent; but they are exclusive of the live stock on ranges, on holdings of not less than three acres, and in cities and villages. The returns show that, in the various States and territories, there were, on June 1st, 1890, 14,976,017 horses, 2,246,936 mules, and 49,109 asses; that, in 1889, there were foaled 1,814,404 horses, 157,105 mules, and 7,957 asses; that there were sold in the same year 1,309,557 horses, 329,995 mules, and 7,271 asses; and that there died, from all causes, 765,211 horses, mules, and asses during the same period. The increase of horses from 1880 to 1890 is shown to be 44·59 per cent., as against 44·95 per cent. between 1870 and 1880, and 14·34 per cent. between 1860 and 1870. The increase of mules from 1880 to 1890 was 26·26 per cent.; between 1870 and 1880 the increase was 61·08 per cent.; while from 1860 to 1870 there was a decrease of 2·24 per cent. Of the aggregate number of horses and mules in the whole colony, in 1890, 86·95 per cent. were horses, and 13·05 per cent. were mules. The North Atlantic group of States had the smallest proportion of mules—2·41 per cent.—while the South Atlantic group had the largest proportion—32·04 per cent., as against 67·96 per cent. of horses. In the North Atlantic division New York and Pennsylvania take the chief place as the producers of horses. In the South Atlantic division, Virginia and West Virginia take the lead in horses; and, in the north-central division, Illinois and Iowa take the front rank as producers of horses; while Kentucky, Tennessee, and Texas take the lead in the south-central division in the production of horses and mules. In the western division California and Oregon are in the advance as regards the production of horses. The per-centage of increase of horses from 1880 to 1890 is shown to be 44·59, very close to the increase from 1870 to 1880, which was 44·95. The percentage of increase of mules for the same period is 26·66 and 61·08. It will thus be seen that, taking the whole country into consideration, the mule is not keeping pace with the horse as a farm animal, but the mule is growing in favour and use in several of the southern States faster than the horse. One reason for the change in the eastern, northern, central, and western States is said to be the falling off in the profits of agriculture during the past decade. The breeding of mules, however, is an industry of considerable importance in Missouri, Kentucky, Tennessee, and Texas, and is largely developing in Kansas, California, Illinois, Arkansas, Mississippi, Alabama, and North Carolina. Under the diversified system of agriculture rapidly spreading in the south, the breeding of horses and mules is growing in favour. For the first time in a United States census

an enumeration of asses, independent of mules, has been made, known as "jackstock," jacks and jennets, and "burros." There are several millions of dollars invested in importing, breeding, and raising this class of animals. The "burro" is said to have advantages over both horse and mule, and their numbers amount to many thousands, principally in New Mexico, California, and Colorado. Census figures show that on the ranges of New Mexico, in 1890, there were 13,074 of these burros employed as pack animals.

RUSSIAN AGRICULTURAL INDUSTRIES.

The *Journal de la Chambre de Commerce de Constantinople* says that there appears to be a strong feeling at Odessa in favour of promoting the development of Russian agricultural industries, and the Minister of the Interior has, for some time past, had under his consideration schemes for an improvement in sheep rearing in the south of Russia, and for increasing the profits derived from this particular branch of rural economy. One of the steps taken to this end, is the introduction of new processes in cheese making with sheep's milk. A commencement has been made in Bessarabia, where there are numerous flocks of sheep, and where considerable quantities of cheese are made, but up to the present the results have not been particularly satisfactory. This province possesses 2,000,000 of sheep, of which only 180,000 are the fine wool species. The ordinary sheep supply the milk with which two descriptions of cheese are made. One, the *kachkaval*, is a cheese of a greenish colour and of an inferior quality, moulded in the form of flat and round cakes, about two or three centimeters thick, and with a diameter of from thirty to fifty centimeters. The other description is a rich white cheese, known as *brinza*, which forms one of the principal articles of consumption for the peasants. *Brinza* and *kachkaval* are exported in considerable quantities to Turkey and Roumania. In 1888 the exports of these cheeses amounted to 2,297 pouds (poud is equivalent to 36 lbs. avoirdupois), valued at 89,507 roubles; and, in 1889, to 41,548 pouds, with a value of 209,745 roubles. Notwithstanding these large exports, the Bessarabian cheese leaves much to be desired from point of view of quality, and barely fetches four roubles a poud, while a similar description made in Italy, and known as *necarino*, is sold for from seven to ten roubles a poud. *Necarino* has been made in Russia, and technologists who have studied its manufacture, have been appointed by the Government to instruct farmers in Bessarabia in the various processes of its manufacture. The rearing of fowls and the production of eggs have received a considerable impetus in Russia, owing to the efforts of the society which has been for some time established with this object. At the present time, about 722 million eggs are annually exported from Russia, and

a company has recently been formed, which is constructing a vast establishment containing twenty automatic incubators, each capable of hatching 7,500 eggs at a time. The Minister of Imperial Domains has it in contemplation, it is said, to open several schools for the purpose of imparting instruction in viticulture, and thus to give a stimulus to the development of this important branch of agricultural industry. Finally, with a view to encourage and facilitate sericulture in Southern Russia, the same official has caused vast plantations of mulberry trees to be planted, so that persons engaged in this industry may receive, gratuitously, young mulberry shrubs, to a number not exceeding 50,000 in the aggregate, each year.

LIMESTONE INDUSTRY IN THE UNITED STATES.

The United States Census Bureau has recently issued a bulletin showing the extent and value of the limestone industry in that country. It shows that ordinary limestone, to the value of 19,095,000 dollars, was produced during the census year from 1,954 quarries, by a force of 30,644 men, who received in wages a sum amounting to 10,122,000 dollars. The total expenses in producing the limestone amounted to 15,093,000 dollars, giving a profit to the producers of 4,000,000 dollars. The capital invested amounted to 27,022,000 dollars, of which 14,771,000 dollars are invested in land. The various purposes for which limestone is used, and the extent to which it is employed in the various industries, are shown in the following figures:—Building purposes, 5,405,671 dollars; converted into lime, 8,217,015 dollars; stone, for burning into lime, 184,000 dollars; flux, for furnaces, 1,569,300 dollars; street-work, 2,383,000 dollars; bridge, dam, and railroad work, 1,290,000 dollars; and miscellaneous uses, 46,000 dollars. In stating the amount of lime, the figures are limited to that manufactured by producers of limestone, and do not include lime produced by lime burners, who purchase stone from quarrymen, and burn it into lime. Limestone is produced in 39 States and two territories; but nearly two-thirds of the value of the product is confined to seven States. These seven States are Pennsylvania, Illinois, Indiana, Missouri, New York, Maine, and Ohio, and the value of the product in each is in the order of the States named. Pennsylvania heads the list, with 373 quarries, and a production valued at 2,655,000 dollars. Illinois comes next, with 104 quarries, and a product valued at 2,191,000 dollars; Indiana, 172 quarries, value of product, 1,289,000 dollars; Missouri, 123 quarries, value of product 1,860,000 dollars; New York, 157 quarries, value of product, 1,708,000 dollars; Maine, 60 quarries, with a value of 1,523,000 dollars; and Ohio, with 221 quarries, and a product valued at 1,515,000 dollars. These are the only States in which the value of the product reaches

1,000,000 dollars annually. In Wisconsin the value is 813,963 dollars; Minnesota, 613,000 dollars; Iowa, 531,000 dollars; California, 517,000 dollars; Kansas, 478,822 dollars; Alabama, 324,814 dollars; and Kentucky, 303,314 dollars. Maine heads the list in the value of lime produced; yet Pennsylvania produces more than twice the quantity produced in Maine. The Maine product comes entirely from Knox county, where large quarries of very pure limestone are worked exclusively for conversion into lime. Pennsylvania produces 4,043,679 barrels of lime, while the production of Maine is 1,903,639 barrels. The value of the Maine output is 1,523,499 dollars, while that of Pennsylvania is only 1,195,955 dollars. This great difference in the relative value of the product of these two States is accounted for by the fact that a large proportion of the lime produced in Pennsylvania is used for agricultural purposes, which require only inferior descriptions; whereas the lime from Maine is almost entirely used for building purposes in many of the principal cities on the Atlantic coast.

THE FORESTS OF ZULULAND.

The Acting Resident Commissioner of Zululand says that the forests in Zululand may be divided with reference to their nature and distribution, into high timber, forest, thorn bush, and coast forests. The high timber forests are situated on the Nkandhla and Qudeni ranges of mountains, in the Nkandhla district; on the Entumeni and Eshowe hills and the Ungoye mountains, in the Eshowe district; on the slopes of the Ceza, and on the Useme, Empembeni, Makowe, and other hills in the Ndwardwe district; and on the Ubombo mountains in the district of that name. The thorn bush is to be found, to a greater or less extent, in all the river valleys of Zululand, the timber increasing in size and the bush in density in the lowest parts of the rivers, especially those of the Umkusi and White and Black Umfolosi. The coast forests are of no great extent, with the exception of the Dukuduku; they grow in small batches along the streams and rivers near the coast, and especially at their mouths, and also cover the low sand hills which border the coast of Zululand. Taking first the high timber forests, the Qudeni forests clothe the slopes and spurs of the Qudeni mountain, a magnificent range rising to an altitude of from 4,500 to 5,000 feet, and situated between the Tugela and Insuzi rivers. The forests are of great extent, and they clothe the southern, eastern, and northern slopes of the mountain. The different portions of the forest are distinguished by names which, commencing on the south side of the mountain, run in the following order:—Hlalikulu, Ingongome, Butshisa, Inkonyene, Ikombe, Undunduzeli, and Ensingabantu. These forests are the finest in Zululand, and are composed of valuable

timber, of the same nature and variety as that of the high timber forests of Natal. Yellow-wood, both *oueniqua* and upright, abounds, and there is also every description of hard wood, but, from want of adequate protection, these forests have, in many parts, been ruthlessly destroyed. The Nkandhla forests are in the district of Nkandhla, which comprises the long range of mountainous country which forms the watershed between the Umhlataze and Insuzi rivers; the highest range, which attains an altitude of at least 4,500 feet, is called Nomance. The Nkandhla forests are of great extent, and are situated chiefly on the southern slopes of the Nkandhla range, one belt of forests, called the Dukuza, being several miles in length, and taking two hours to traverse on horseback. These forests are said to be even finer than those of Qudeni, but they do not, it is stated, possess so much yellow wood, and the timber is not so fine. The Entumeni forests are situated on the high lands, which rise to an altitude of 2,800 feet between the Mhlatazi and Malikulu rivers. The timber in these forests is inferior to that of the Qudeni and Nkandhla. The Eshowe forests are not very extensive; they grow in patches on sheltered kloofs and hollows, and along watercourses and streams filling up the valleys. They are most abundant on the eastern and southern slopes of the Eshowe range. They furnish no hard woods of any value; the timber consists principally of the white iron wood (Umzani), which is of little use, the Kaffir plum (Umgwenya), which is good for furniture, and the Madubi, which is used by Kaffirs for making spoons and dishes. Some of the woods are at an elevation of 2,000 feet, and others grow at a few hundred feet above sea-level. Next to the Qudeni and Nkandhla, the Ingoye forest is the finest in Zululand, and is situated along and on the southern slopes of the Ingoye range, which forms the watershed between the Mhlatazana and Mlalazi rivers; it grows at an altitude of from 1,000 to 1,500 feet, and is of great length, extending from ten to twelve miles. It is a virgin forest, in the sense that it has never been cut into by sawyers, but the work of denudation by the natives is very apparent. This forest is very rich in timber, one description furnishing blocks 4 feet in diameter and 20 feet in length. Bastard, or *oueniqua* yellow wood is plentiful, but very little of the real or upright kind, and milk wood, white pear, and sneeze wood are to be found. It is stated that the timber in the forest is best for furniture, but that durable hard woods are not so good as in the Qudeni and Nkandhla forests. The Ubombo forests grow in small patches on that part of the Ubombo range within Zululand; the largest covers about ten acres. The timber mostly consists of hard wood, but is not of large size. A series of small high timber forests extend in a northerly direction from the Useme hills at the source of the Hluhluwe river to the Makowe hills. With the exception of the Gome and Ezibayeni forests, they are called after the names of the hills on

which they are situated. Very little is known of these forests by Europeans, but they appear to contain the trees common to high timber forests, and to grow for the most part in small patches in kloofs and on steep declivities. The Ceza forest is situated on the eastern slope of the Ceza hill, between the Isekwebezi and Black Umfolosi rivers, and on the borders of the Transvaal, and is a continuation of the Ngome forest. It extends for about a mile and a half, with a breadth of 200 to 300 yards. The thorn bush covers large areas, and grows fine trees in the lower parts of Zululand; the timber is of but little value except for fencing purposes and fuel. The coast forests contain some descriptions of hard wood, but the trees are all of a dwarfed, stunted, and twisted description, and of very little use for building purposes or waggon making, except for small parts such as naves, though serviceable for furniture. The Acting Commissioner concludes his report by suggesting certain measures for the better preservation of the forests of Zululand.

General Notes.

EUROPEAN FLAX TRADE.—Russia produces more flax than any other European country (about 900 million lbs. weight in 1889). The export of flax seed from Russia is between 12 and 14 million bushels. Austria-Hungary (104½ million lbs.) comes next to Russia, followed by Germany (97¼ millions), France (79¼ millions), Ireland (47 millions), Belgium (43¼ millions), and Italy (43¼ millions).

CANADIAN EGGS.—The trade in Canadian eggs, which are said to be superior to the best Irish eggs, has largely increased of late. They weigh from 15 to 17 lbs. per 120, while the best Continental eggs weigh from 13 to 15 lbs. only. The packing is stated to be superior to that of any Continental shipments, and the trade is supposed to be placed upon a permanent footing. The *Canadian Gazette* reports that in 10 days 3,000,000 Canadian eggs were landed at Liverpool alone.

EXHIBITION OF FINE ART PRIZES.—The *Builder* notices a scheme for an exhibition at the Ecole des Beaux Arts, Paris, to consist entirely of the works of winners of the Prix du Salon and of the Bourses de Voyage, since the origin of these prizes; and remarks that considering what brilliant and celebrated men have won these prizes since 1874, such an exhibition ought to be very interesting, but it seems extremely difficult to realise, as most of the works are in the departmental museums or in the Luxembourg, whence there will be difficulty in extracting them, and other executed works are in the public gardens, and it would be a great expense to remove them temporarily.

Journal of the Society of Arts.

No. 2,027. VOL. XXXIX.

FRIDAY, SEPTEMBER 25, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damasks, Chintzes, &c., regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the Annual Competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1892, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones' "Principles of Design," and the Society's Bronze Medal.

Chicago Exhibition, 1893.

Forms of application for space, and prospectuses with detailed information, will not be issued till October, but, in the meantime, intending exhibitors can apply to the Secretary

of the Society of Arts, and their names will be noted at once, with a view to their receiving early copies of the prospectus when ready.

A few copies of the Regulations for Foreign Exhibitors, and Rules for the Department of Fine Arts, which were printed in the last two numbers of the *Journal*, have been received, and copies may be obtained on application to the Secretary, John-street, Adelphi.

THE MINERAL RESOURCES OF NEW SOUTH WALES.

By C. S. WILKINSON, F.G.S., F.L.S.

The leading industrial position which England occupies amongst the nations is, we all know, to a great degree attributable to the development of her mineral resources. In this fact we have assurance of the high national destiny which awaits Australia in the not distant future; for not only does Australia possess, to an equal extent, the greatest of England's mineral basis of industry, coal, but our island continent has, in addition, inexhaustible stores of the noble metals, gold and silver, which are of such national importance. Of the world's total production of gold since the year 1851, Australia has contributed about one-third, amounting in value to over £336,000,000, and the value of the silver now annually raised amounts to about £1,715,000. While the production of these alone points to Australia as one of the chief regions for the world's supply of the metals which form the legal money currency of the principal nations, the industrial national prosperity of Australia is foreshadowed in her possession of undeveloped deposits of almost all the known minerals of commercial value. By far the greater number of these occur in New South Wales, and it is remarkable also that, within the boundaries of this colony, nearly all the characteristic physical features of the Australian continent are found represented. It embraces the highest mountains, the largest rivers, the most extensive plains, and some of the finest forests; and its climate varying from sub-tropical to Alpine, with an average rainfall of from 59 inches on the coast to ten inches in the western interior, is adapted for the pursuit of almost every branch of the pastoral and agricultural industries.

Until lately the Colony of Victoria, which has yielded £225,128,056 of gold, has ranked first among the Australian colonies in regard

to annual mineral productions: but now New South Wales occupies the premier position, as is shown by the following returns for the year 1889:—

New South Wales	£4,761,046
Queensland	2,743,267
Victoria	2,472,962
New Zealand	1,493,167
Tasmania	458,471
South Australia	426,210
West Australia	63,575

Australasia total....£12,418,698

The total value of minerals raised in Australasia, to the end of 1889, is estimated at about £421,398,311.

At the end of 1890, the total value of the minerals raised in New South Wales amounted to £86,685,704. Previous to 1851, the year of the gold discovery, the value of the annual production only reached £720,406; but, during the next 10 years, ending 1861, this was increased to £14,997,043; in 1871, to £31,635,617; in 1881, to £55,077,507; and, in 1890, to a total of £86,685,704, the value of the yield during the year 1890 being £5,241,514.

In reviewing the above, we must endorse the words of Mr. Harrie Wood, the Under Secretary for Mines, that "such returns cannot fail to show the increasing and national importance of the mining interests of New South Wales."

Practically, this rapid development has taken place since the discovery of gold; for during the 40 years of this period, the value of the average annual production has amounted to £2,167,142; while, during the 19 years previous to 1851—when coal alone was raised—it was only £37,695; and it is interesting to note that each of the four successive decades, from the year 1851, have been marked by the commencement of the development of our principal metallic mines: the first of gold, the second of copper, the third of tin, and the fourth of silver.

During the whole of this period, with but few intervening depressions, the yearly output of coal has been constantly increasing. The other minerals of commercial value are antimony, iron, manganese, chromite, cobalt, bismuth, zinc, tungsten, platinum, asbestos, diamonds and other gem-stones; alum-stone, building-stones, marble, serpentine, brick and pottery-clays, kaolin, ochres, tripolite, roofing-slates, and flagging.

I will first refer to coal, as it is our mineral of greatest industrial importance.

COAL.

Coal was discovered in New South Wales in the year 1796, but the value of the quantity raised up to the year 1832 was only £4,194. The value of the total production to the end of 1890 is £24,066,244, the yield for 1890 being 3,060,876 tons, valued at £1,279,088. The coal measures are of the Carbonifero-Permian age, and occupy an area of over 23,000 square miles. There are three principal series which contain workable seams of coal; they have been grouped as the lower, middle, and upper coal measures. The *lepidodendron* beds, which are the equivalent of the English coal measures, occur below these, but there are no workable seams in them. The lower coal measures contain the Greta and West Maitland seams, and consist of plant-beds with massive conglomerates, both above and below them, full of marine fauna, *producta*, *spirifer*, &c., of Carboniferous age. Next in order come the middle coal measures, consisting of fresh-water plant beds, embracing the East Maitland coal seams; and above them are the upper coal measures, also plant beds, containing the Newcastle seams. The three series are well developed in the Hunter River coalfield, and *glossopteris* is one of the characteristic fossil plants in each of them. The seams of coal vary from 3 feet to over 30 feet thick, containing an aggregate thickness of 130 feet of coal. These include the seams of coal which are worked in the Newcastle, Maitland, Greta, Singleton, Curlewis, Katoomba, Lithgow, Capertree, Mittagong, Bundanoon, and Illawarra or southern coalfields. But beyond these, in the Talbragar district to the north-west, the Clarence district to the north, and the Clyde river, or Jervis bay, to the south of Sydney, occur other seams of good coal, not as yet worked, of an aggregate thickness of at least 50 feet of coal.

Those in the Talbagarar and Clarence district are believed to be of Triassic age. The thickest seam as yet proved is the upper seam in the lower coal measures near West Maitland. In one place it is 32 feet thick, with only a few bands, and contains the remarkable thickness of 29 feet of coal. This splendid seam, with two others below it, together contain 41 feet of workable coal, but they vary in thickness. Mr. T. W. E. David, B.A., F.G.S., Geological Surveyor, through whose survey they were discovered, assumes, for safe calculation, only

15 feet as the average thickness, and estimates that throughout an area of 20,000 acres occupied by the coal companies, the marketable coal available is worth over £132,000,000 sterling. This area is only a portion of one of our extensive coal-fields. The nearest colliery to Sydney is that of the Metropolitan Coal Company, 28 miles by rail south from Sydney, and is working a seam 12 feet thick. Near the Illawarra railway, in the Jamberoo district, there is a coal seam, which attains a thickness of over 20 feet, as yet unworked. Some anthracite coal is also found in this locality near trap-dykes.

The coal of the Hunter River and Curlew fields is chiefly of a bright bituminous character, yielding up to 40 per cent. of volatile hydrocarbons, and therefore suitable for gas, household, and steam purposes; while that of the western, south-western, and southern coalfields is less bituminous, but highly esteemed as a steam coal. The upper seam in the Hunter River series, which is worked in the Northumberland colliery, is also of this nature. Excellent coke is produced from them. The seams worked crop out at the surface, or within a workable depth, in numerous localities—some near the principal shipping ports, others in the inland districts, and many are favourably situated for manufacturing industries; the metropolis, Sydney, being especially so, having the principal coal-fields surrounding it on the north, west, and south, while it occupies almost the centre of a great coal basin, beneath the surface of which, at depths of 2,231 feet at the Sutherland and 2,600 feet at Liverpool, as proved by diamond drill borings, the seams have been found to extend. A bore, now 2,100 feet deep, is being put down at Cremorne, on the north shore of Sydney harbour.

Besides the seams already named, there are other thick seams of good coal containing too many bands for them to be worked in the ordinary way; but if treated by coal-washing appliances, such as the "Luhveg" coal-washer, they could be properly worked, and would prove a great boon, especially to the inland towns, railways, and smelting works. The use of small coal for the manufacture of briquettes will also economise the coal supply. But the sources of supply are practically inexhaustible, as the seams of coal extend under such large areas.

It has been estimated that the New South Wales coal seams, which are over $2\frac{1}{2}$ feet thick, and within a depth of 4,000 feet, con-

tain, after allowing one-fifth of their total contents for loss and waste in working, &c., 78,198,200,000 tons of coal—a quantity about equal to that which the coalfields of Great Britain are said to contain.

The present important and increasing inter-colonial and international relationship of New South Wales, in regard to the coal trade, is evident from the fact that 35·8 per cent. of the total annual production is exported to the Australian colonies (Victoria alone taking 22·2 per cent.) and 29·4 per cent. to foreign parts, San Francisco, &c.; while the remaining 34·7 per cent. supplies the home consumption. The demand for America is chiefly for the gas coal from the Hunter River coal-field, especially for that of the "Greta" seams in the lower coal measures, which yields to 40 per cent. of volatile hydrocarbons. The large ocean-going steamers generally use the less bituminous steam coals of the Illawarra coal seams.

KEROSENE SHALE.

The middle and lower coal measures contain, in addition to ordinary coal, seams of petroleum oil cannel coal, which vary in thickness up to 5 feet. This remarkable coal, usually called "kerosene shale," is the richest of the kind yet found in the world; and it is interesting to know that the Hon. Sir Saul Samuel, K.C.M.G., C.B., the Agent-General for New South Wales, was the first to work it in the colony. It yields, on analysis, as much as 84 per cent. of volatile hydrocarbons, and produces 150 gallons of crude oil per ton, or 18,000 cubic feet of gas with an illuminating power equal to 40 candles. It has been principally worked for the manufacture of kerosene oil, and for mixing with coal, for increasing the illuminating power of the gas made therefrom, at Hartley, Joadja Creek, and America Creek; it occurs also at Katoomba, Megalong, Bathgate, Capertee, Colley Creek, and in several other localities. The best shale realises about £3 per ton. The value of the shale raised in 1890 was £104,103.

Coal mining may be considered one of the most reliable of the mining industries of New South Wales for the investment of capital, in view of the inexhaustible sources of supply, and the rapid industrial progress of the colonies. The output of the coal has been more than doubled within the past nine years, and its average selling price is about 10s. 8½d. per ton.

GOLD.

Gold mining, as is well known, has played a most important part in the history of Australasia. The first recorded discovery of gold dates back to the year 1823; but the actual mining for gold commenced in 1851, and the production to the end of 1890 amounts in value to upwards of £336,000,000 sterling, which includes £38,000,000 in New South Wales, £227,000,000 in Victoria, £26,000,000 in Queensland, and over £46,000,000 in New Zealand. The yield during the year 1889, from all the colonies was £6,474,198, of which New South Wales contributed £434,070; and the yield for 1890 was £460,284.

Gold was first obtained from the alluvial drifts, and it was traced up to the reefs, from the degradation of which the greater portion of it was derived, while some has been precipitated from an aqueous solution permeating the rocks and drifts, and some also has been derived from the disintegration of auriferous basalt and other rocks. The auriferous reefs occur traversing silurian, devonian, and carboniferous strata, and in granite, porphyry, diorite, serpentine, &c. The drift deposits resulting from the denudation of these rocks are found in the Carboniferan, Permian, Cretaceous, Eocene, Miocene, Pleistocene, and recent formations. In quartz reefs and metalliferous lodes gold is generally found associated with sulphides of iron, copper, lead, silver, zinc, bismuth, arsenic, &c., and in ores resulting from the oxidation of these metals. It is also more or less alloyed with silver, osmium, and tellurium. The various modes of occurrence of gold afford a wide subject of great interest.

The yield of gold from alluvial deposits is decreasing; but there are considerable areas of country as yet unprospected, and, doubtless, the "deep leads," not yet worked out, will themselves afford profitable employment to miners for many years to come, such as in the Gulgong goldfield, from which, during the first seven years of its prosperity, 16 tons of gold were obtained. A permanent and increasing supply is anticipated from the numerous unworked gold-bearing reefs, in addition to those which are now being mined.

Hitherto there have been many failures in reef-mining, some, if not the majority, of which have resulted from preventable causes, such as mismanagement, want of suitable appliances, and ignorance of the modes of occurrence of the gold in the reef. The latter are very

important to recognise; for, in most instances, the gold occurs, not evenly distributed throughout the reefs, but in irregular patches or "shoots." There are also reefs containing sulphides of iron, lead, zinc, &c., which require special appliances for their treatment, first, as regards concentration of the sulphides, which are often very complex; and, secondly, efficient chemical or other methods of treating them. For working such auriferous ores, New South Wales offers a large field for mining enterprise. The treatment of gold-bearing antimony ores, of which there is likely to be a very large yield in the New England and Macleay districts, is deserving of special attention.

SILVER AND LEAD.

Silver mining in New South Wales has recently attained great prominence. If we take the value of the silver produced in 1889, together with that of the lead, with which it is chiefly worked, the amount—£2,762,554—exceeds that of any of the other mineral products, coal ranking next in value, viz., £1,279,088, or, with that of the kerosene shale added, £1,383,191. The silver lodes traverse Silurian and Devonian strata and the igneous rocks, chiefly granites, which intrude them. The most important lodes yet opened are at Broken-hill, the Pinnacles, and Thackaringa, in the Barrier Ranges, Mitchell, and Sunny Corner, Captain's-flat, Lewis-ponds, Cordillera, and Costigon. The ores from several of these yield also a fair quantity of gold. There are numerous other silver lodes—in the Barrier Ranges, Castlereagh, Denison Town, Boorook, Rivertree, Woolombi, and other districts—which command attention. The largest yet worked is the Broken-hill lode, traversing Silurian gneissoid schists, and consisting of gossan and manganese oxide, with carbonates of lead, &c., &c., and sulphides of lead, iron, zinc, copper, and silver; also some native silver. The Broken-hill Company's Mine on this lode has yielded, since May, 1886, to 30th November, 1890, 20,811,710 ounces of silver from 516,228 tons of ore treated, besides 83,413 tons of lead, the total gross value being £4,757,722. In the Vegetable Creek District the silver lodes contain Fahlerz with sulphides of lead and zinc. At the Sunny Corner Mine, during one year, 24,547 tons of ore were furnished, producing 634,016 ounces of silver, and 6,413 ounces of gold; the ores of this locality also contain copper and lead. Notwithstanding the large and increasing

yields from the Broken-hill Lode, there is not likely to be an over production of silver from the various mines; for as the more easily worked oxidised ores in the upper portions of the lodes become exhausted, the cost of treatment of the sulphide ores at the lower levels must increase, but with improved concentrating and reducing appliances, and from the fact that numerous small lodes will also yield considerable supplies of ore, the present annual production of silver is likely to be maintained for some years to come. The introduction of efficient processes for saving the lead, zinc, copper, &c., associated with the silver, should also add to the permanence of the industry, and there are considerable tracts of country occupied by the geological formations in which other silver-bearing lodes will probably be found. The silver ores consist chiefly of chloride, chloro-bromide, iodide, and sulphide of silver, with occasionally native silver; these are usually associated with carbonate and sulphide of lead, the lead occurring in such quantity as to be profitably extracted with the silver as silver lead bullion. For instance, from the Broken-hill Proprietary Mine 516,228 tons of silver ore smelted yielded 83,413 tons of lead. From the Sunny-corner Mine, 24,972 tons of ore yielded 201 tons of lead, 309 tons of copper, and 1,256 tons of matte, containing 319,324 ounces of silver, and 2,300 of gold, valued at £74,209. From the Cordillera Mine, in the Tuena district, 9,300 tons of ore yielded 227 tons of lead, besides 220 tons of copper, 82,800 ounces of silver, and 404 ounces of gold, valued at £37,343. Then, 500 tons from the Lewis Ponds mine yielded at the rate of 10 per cent. of lead, and 30 ounces of silver and 5 dwts. of gold per ton. Other instances also might be given, for which I will refer to the "Annual Reports of the Department of Mines, Sydney." On account of the silver and lead being worked together, I have referred to them under the one head, and it will be perceived that the production of lead will be large.

TIN.

Tin mining is also one of the important industries of New South Wales. The annual production of tin is nearly equal in value to that of gold, the yield for 1890 being 392,841 tons. The total production to the end of 1890 amounted to £9,255,384. Mining for tin commenced in the year 1871, and the ore obtained has been chiefly stream-tin, washed from the alluvial drifts and beds of existing streams,

and also from older alluvial deposits in the channels of the streams of the tertiary and probably cretaceous periods. These ancient stream deposits are called "deep leads," for they are sometimes buried to a depth of 200 feet beneath more recent accumulations, including thick flows of basalt. The richest deep leads yet worked are in the New England district, and their fossil flora indicates them to be of eocene age. In the Vegetable Creek tin-fields alone Mr. Geological Surveyor David has mapped out 49 miles in length of "deep leads," of which only about 4 miles have, as yet, been worked out, yielding very rich returns during the past eighteen years. In the northern, or New England district, the formation containing the tin lodes, from the denudation of which the tin-bearing drifts have been derived, are granite, porphyry, and metamorphosed sedimentary beds of Devonian or lower carboniferous age; but in the Barrier ranges in the western part of the colony, the tin oxide occurs disseminated through very micaceous granite-dykes intruding Silurian gneissoid schists. Owing to the scarcity of surface water in this district, and the patchy occurrence of the tin ore, they have, as yet, not been profitably worked. But, as I believe that large quantities of ore might be raised, yielding up to 5 per cent. tin oxide, and water obtained by conserving the rainfall, if not by sinking, there seems to be no reason why these tin-bearing dykes may not be profitably worked. The granite dyke-stone is very micaceous, resembling the tin-stone from Port Darwin in North Australia, and from Harney Peak in America. For its efficient treatment it will, no doubt, require special crushing and concentrating appliances. In the New England district, the tin lodes have hitherto been very little worked; the principal lode yet opened is "The Ottery," near Vegetable Creek, from which one crushing of 1,200 tons yielded nearly 5 per cent. of tin ore, and other crushings a little over 3 per cent. Lead, copper, bismuth, gold, silver, wolfram, &c., are sometimes found in the lodes. The tin-mining industry may be regarded as one of great permanence.

COPPER.

Numerous copper lodes have been opened in the colony. They chiefly traverse Silurian formations, with the exception of the Gordon copper mine, which is in granite, and is partly worked for gold. The largest and most extensively worked lode is that at Cobar, which

attains a width of 100 feet. Other lodes have been worked at Thompson's Creek, Mount Hope, Peelwood, Carangara, Wiseman's Creek, Malong, Frogmore, Balara, Blayney, &c. They all consist of gossan with copper carbonates, from the surface downwards, until the unoxidised sulphides are met with. Lead, zinc, gold, silver, tin, and bismuth are occasionally met with in the copper ores. Mining for copper commenced in the year 1858. The largest annual production was in the year 1883, and was valued at £557,201. The subsequent low price of copper, together with cost of long land carriage to shipping ports, have had the effect of closing some of the mines; but now that the market has improved this industry is reviving, and the output for 1890 realised £173,311. Large quantities of low grade ores exist, which, I believe, might be profitably treated by a wet process, such as that used by the Tharsis Copper Company.

ANTIMONY.

Antimony lodes have been worked in the Macleay, New England, Gulgong, and Crudine districts. They traverse Devonian sedimentary beds in association with granitic dykes. The ore, oxide and sulphide of antimony occurs chiefly in branches in the lodes, thus necessitating very irregular mining operations with uncertain output.

Some years ago, several thousand tons were raised from the Carangula mines in the Macleay district, but, partly owing to the then low price of the metal, the mines were stopped; the recent increase in the value of antimony should now lead to the reopening of these mines. The lodes at Hillgrove are being worked principally on account of gold, but they contain also a large proportion of antimony.

In various parts of the country between Hillgrove and the Nambucca-Bellinger district, gold-bearing antimony lodes have lately been found; so that there is a good prospect of a considerable development in mining for these metals in this part of the colony. At Razor Back the lode, though small, is similar in mode of occurrence. It is to be hoped that an efficient and economical process for extracting gold from these antimony ores will soon be introduced.

IRON.

Another of our sources of future wealth is iron mining, which is in its embryo state of development.

Near Mittagong and Berrima deposits of rich limonite, or brown iron ore, occur in the middle of a coalfield, with limestone not far distant, near Marulan. These deposits, with those near Picton, I have estimated contain in sight about 8,234,000 tons of ore, giving an average yield, on analysis, of about 45 per cent. of metallic iron. In the adjoining Goulburn district there are other deposits of rich ore. Some years ago an attempt was made to work the deposits at Fitzroy, but without success. Recently, however, Mr. A. Brazenall, of Fitzroy, has been smelting the ores on a small scale, and using the iron in his foundry. Smelting works were also established at Lithgow, to reduce the ores of the Lithgow, Wallarawang, and Blayney districts; but these works changed their operations to smelting and rolling old iron. The iron ores available for Lithgow consists chiefly of limonite, occurring as thin irregular clay-bands of rich quality in the coal measures, together with more aluminous and silicious ores in shale beds and veins in the overlying Hawkesbury series. Limonite and magnetite, with garnet ore in lodes and irregular patches, near Wallarawang, and patches of rich limonite and magnetite in the Blayney district.

Reports on these have been made by Professor Liveridge, F.R.S., Mr. Carne, F.G.S., and myself. Limestone is abundant on the railway line at Wallarawang.

Mr. Geological Surveyor David, F.G.S., has recently reported on some rich beds of magnetite near Stroud and Musswellbrook, in the vicinity of limestone, and not far from a coalfield. This magnetite, however, contains titanium. He has also reported on the brown hematite deposits near Rylstone, which, with those of the adjoining districts, are estimated to contain 2,226,000 tons of ore, yielding 43 per cent of metallic iron.

I have estimated that the three principal localities, Fitzroy, Wallarawang, and Rylstone, where coal and limestone are abundant, embrace iron ore deposits, together containing about 12,944,000 tons of ore, capable of yielding 5,853,180 tons of metallic iron.

It would, probably, be advantageous to establish iron or steel works in the Newcastle or the Illawarra coalfields on the coast, where excellent coke is made, and bring the iron ores there from inland, or from the large deposits which are said to exist in New Caledonia.

MANGANESE.

Rich ferro-manganese ores are found in the

Bendemere, Glanmere, and Rockley districts ; also near Goulburn and in the Barrier Ranges. Several hundred tons have been shipped to England ; but, as yet, the deposits have not been much worked.

Ferro-manganese, for steel manufacture, might probably be profitably produced in the colony for export.

CHROMITE.

Irregular deposits of chromic iron occur in the Serpentine formation at Bowling Alley Point, Bingera, Young, and Gordon-Brook.

COBALT.

Cobalt has been, to some extent, worked in the manganese ores, yielding up to 4 per cent. cobalt at Bungonia ; and some rich arsenide ores, containing, according to analysis, up to 13.83 per cent. of cobalt, have been found on private property near Carcoar.

BISMUTH.

Bismuth has been worked to some extent (ore to the value of £36,141 having been exported), chiefly from quartz lodes, at Kingsgate and Hognes Creek, near Glen Innes. It also occurs at Silent Grove, the Gulf, Elsinore, Tenterfield, Adelong, Mount Gipps, near Broken Hill, Gumble, and near Captain's Flat. In the lodes at Kingsgate, pieces of metallic bismuth have been obtained from a few ounces up to 50 lbs. in weight.

MERCURY.

Cinnabar (sulphide of mercury) occurs disseminated through tertiary clays and drifts, and in the underlying slate rocks on the Cudjegong River. Attempts have been made to work it, but, so far, without success. I believe, however, that the deposit could be profitably worked if operated upon in a more systematic manner than it has yet received. Cinnabar has also been recently discovered in Serpentine, near Bingera and Solferino.

ZINC.

Sulphide of zinc has been found in some abundance in the silver lodes at Broken Hill and Castle Rag. I understand there is a ready market for sulphide of zinc at Swansea and Belgium. This mineral is found, more or less, in many of the metalliferous reefs throughout the colony, as at Morurga and Drake.

TUNGSTEN.

Wolfram (tungstate of iron) occurs in some quantity in the bismuth lode at Hognes creek,

near Glen Innes and in a large reef near Emmaville. Schneelite (tungstate of lime) has been found in small reefs near Hillgrove. These minerals have not yet been worked.

PLATINUM.

Platinum has been washed from the auriferous sands on the sea beach in the Richmond river district. If these sands were operated upon on a large scale, the platinum might, I believe, be profitably extracted along with the gold. In alluvial deposits on slate formation near Parkes, platinum has been found in scattered grains with gold, and lately it has been discovered, *in situ*, in ironstone lodes near Orange, and near Broken Hill.

ALUMSTONE.

A large deposit of Alumstone, yielding up to 80 per cent. of alum, has been opened at Bullahdelah by the Australian Alum Company. This mineral is to be exported to special works near Liverpool for the manufacture of alum. During 1890, 220 tons were raised, valued at £3,000.

DIAMONDS.

Mining for diamonds was carried on in 1869-1872, on the Cudjegong river, near Mudgee, and near Bingera. Some 10,000 diamonds were then obtained, but the work not proving profitable, was almost abandoned until within the last few years, when further prospecting led to the opening of other extensive deposits in the Capes Creek district, near Inverell, of the same character as those of Bingera. Diamond deposits also occur near Mittagong and Burrigong. About 50,000 diamonds have been obtained. In weight they averaged nearly half a carat, though many have been obtained up to two carats in weight. The largest diamond recorded weighed five carats. Many are of the "first water," but in colour they are chiefly pale straw-yellow several of pale and dark green, brown, and black colour have been found. Diamonds occur in the old tertiary drifts, and in the drifts resulting from the denudation of these. As they have not been found in any formation older than the tertiary, it has been suggested that they have been formed *in situ* in it, but it is not impossible that they may have been originally derived from highly metamorphosed sedimentary formations, believed to be of carboniferous age, which has been intruded by granite and extensively denuded in the localities where the diamond drifts occur.

I am of opinion that diamond mining will become a profitable industry. In places good results have been obtained by working on a small scale with Hunt's diamond separator, but if the deposits were operated upon with appliances capable of putting through large quantities of the drift, the industry would become established. Besides diamonds, sapphires, beryl, emeralds, topaz, zircon, ruby, amethyst, garnet, tourmaline, and other gem stones have been found in some abundance.

Recently some emerald mines have been opened in New England, where this gem occurs *in situ* with beryl, topaz, and fluor-spar, in felspathic lode stuff, at the junction of granite and Devonian sedimentary rocks.

SLATES AND FLAGGING.

Roofing slates and slate flagging of good quality are obtained from the quarries at Milla Nurra, near Bathurst, also near Gundagai, and Goulburn. Splendid sandstone flagging is quarried near Orange, Burrowa, and at Buckingbong, near Narrandera.

BUILDING STONES.

Sydney is specially favoured with a very fine building stone which is quarried from the beds of sandstone of the Hawkesbury formation which underlie the city. This great sandstone formation extends for many miles to the north, west, and south from Sydney. The stone is of a light sepia brown colour, sometimes white, and samples of it from Pymont, of which the Sydney Post-office is built, have withstood a test of 200 tons pressure. Excellent sandstone is obtained from the coal measures and from the Devonian beds in various parts of the colony. Granite is available in many districts. The gray granite, of which the large polished pillars in the Post-office and other public edifices and the large pedestal for the Queen's statue near Hyde-park are composed, comes from Moruya. A more beautiful granite, containing large crystals of adularia-felspar, is quarried at Montague Island. A very desirable easily worked syenitic granite is quarried at Bouval. Marble occurs in large masses near Wallerawang, Blayney, Marulan, Mudgee, Wellington, Kempsey, Tamworth, and other localities. It varies in colour from white, grey, and red to black, and has been chiefly quarried for flooring tiles and mantelpieces.

The Wianamatta shales, and the shale beds in the Hawkesbury series and in the coal measures afford material in great abundance for almost all kinds of brick and pottery making.

Ochres, suitable for paint manufacture, occur in various parts of the colony.

INFUSORIAL EARTH.

A large deposit of infusorial earth, of Tertiary age, occurs near Barraba, and another deposit, of better quality, has been found near the Warrumbungle mountains. Some good samples have also been sent from the Menindie district. This earth will probably be in demand for the manufacture of explosives.

From the foregoing, it will be seen that New South Wales possesses numerous minerals of economic value, many of which are already more or less extensively worked, whilst others are awaiting the employment of labour and capital for their development. The chief of these mineral resources, coal, exists in immense quantity, and, as it is perhaps the most important factor concerning the profitable working of the many industries which will, sooner or later, be established in connection with the development of these resources, we may anticipate the settlement of a very large industrial population in this portion of Australia. And when we consider, in addition to the mineral resources, the vast pastoral and agricultural capabilities of the colony, its unrivalled climatic conditions, and its geographical position on the Pacific seaboard, so favoured for commercial intercourse with America, Asia, and other countries, we are assured not only of the future industrial greatness of New South Wales, but also, when federated with the Australian colonies, of her important international relationship.

MADRID AMERICAN EXHIBITION.

Information has been received from the Foreign office, through the Department of Science and Art, respecting an Historical American Exhibition to be held at Madrid in 1892, to commemorate the fourth centenary of the discovery of America by Columbus in 1492. The Exhibition is to consist of objects tending in any way to illustrate the history of America at the period of its discovery.

The Exhibition will take place in Madrid in the palace destined for the Library and National Museum, which will be inaugurated on this occasion, as well as in the park of Madrid. It will be opened to the public on September 12th, 1892, and close on December 31st following.

For the examination and adjudication on the merits of the objects exposed, an international jury will be appointed, and the number of its members

will be determined in proportion to the number of exhibitors and the importance of the objects exhibited.

The prizes to be granted will consist of diplomas of the following grades:—

- First Prize of Honour.
- Gold Medal.
- Silver Medal.
- Brass Medal
- Honourable Mention.

The diplomas will be accompanied by a medal commemorative of the Exhibition, and will be the same for every kind of prize.

This Exhibition will be in connection with a Congress arranged to commemorate the discovery of America, which offers prizes for essays on the subject.

Further information can be obtained from the Managing Committee of the Exhibition at Madrid.

AUSTRO-HUNGARIAN RAILWAYS AND THE ZONE SYSTEM.

The construction of railways has been greatly stimulated in Austria-Hungary by a regulation on the part of the Government, guaranteeing the payment of interest on, and the amortization of, the capital stock invested in railways. The United States Consul-General at Vienna says, in his last report, that the total length of railway lines in Austria-Hungary, at the end of 1890, was 16,312 miles, as compared with 15,896 at the corresponding period of 1889. The number of passengers conveyed from January to November, 1890, was 85,660,353, showing an increase of 16,476,496 passengers over 1889. This considerable increase of the passenger traffic is due, it is said, to the recent introduction of the so-called zone tariff on several lines. In Austria, as distinguished from Hungary, there are, at the present time, 11,153 miles of railway line, and the capital invested is about 2,835,000,000 of florins. These lines are partly the property of the State, or under its administration, and the rest are owned by companies. Of late years the Austrian Government has built several important lines of railroad at the cost of the State. The whole length of lines owned by the Austrian State, or worked by it, amounts to 3,701 miles, and is divided into four groups, as follows:—(1) The western group, including the Western, Rudolf, Franz Josef, and Arlberg railways; (2) the Moravian, Transversal, Moravian Greuz (frontier), and Galician railways; (3) the Istrian railways; and (4) the Dalmatian lines. The working of these lines is under the management of the general direction of the Austrian State railways. The rolling-stock consists of about 1,080 locomotives, 900 tenders, 2,500 passenger carriages, 700 mail coaches, and 18,000 goods wagons. The capital stock invested for the construction or the acquisition of

the lines, and, for subsequent investments, amounts to about 800,000,000 florins. The general direction is assisted by the *Eisenbahnrat*, which is a consultative committee, whose members are chosen from the classes of the most influential landowners, merchants, manufacturers, and agriculturists, who are nominated by the Minister of Commerce, and whose names are submitted to the Emperor. Numerous beneficial railway reforms are said to owe their origin to this consultative body. The private railways of Austria have a length of 6,000 miles, the capital stock invested is 2,000,000,000 florins, and the principal lines are the Staatseisenbahn, Südbahn, Nordwestbahn, and the Galician Karl Ludwigsbahn. The results from the different railway shares vary very considerably; while some lines, such as the Moravian and Prague Dux, have paid no dividends for a number of years, the Aussegg-Teplitz line, on the other hand, pays 20 per cent. and over. In general, it may be said that, with the exception of some lines—as, for instance, the Südbahn—the returns vary from 6 to 8 per cent. Of local lines, there is, at present, in Austria, a total length of about 621 miles, established at a cost of nearly 33,000,000 florins. The total length of the Hungarian railways is about 5,000 miles. The principal feature connected with these lines is the cheap zone tariff introduced on the Hungarian State railways by the Hungarian Minister of Commerce. The State railways of Hungary have a length of about 3,400 miles, and a rolling stock of 750 locomotives, 650 tenders, 2,050 passenger carriages, and 16,500 goods wagons. The seat of the general direction is at Buda-Pesth. On the 1st August, 1889, the zone tariff was established on all the lines owned or managed by the Hungarian Government, and the system thus far has proved so advantageous both to the travelling public and to the profitable working of the lines, that, soon after, similar measures were adopted in Austria and in part of Germany. The zone tariff, as introduced in Hungary, divides travelling on main lines into fourteen principal classes, and that on the branch lines into two classes; these classes are called zones, and for one or more of these zones tickets are issued that entitle a passenger to travel from the starting place to the end of the zone or to any point within that zone. For example, any distance exceeding 140 miles belongs to the fourteenth zone, and with a ticket purchased for that zone, a passenger may travel from Buda-Pesth to Fiume, a distance of 378 miles, or to Predeal, a distance of 473 miles, for a sum varying from 4 to 9·6 florins, according to the kind of train and the class of carriage. On a similar plan, the forwarding of passengers' luggage has been divided into three classes or zones, but free weight of luggage is no longer allowed, the former allowance of 50 pounds of luggage for each passenger being abolished. As a starting point for calculating the distance, Buda-Pesth was fixed upon, so that distances not starting from Buda-Pesth do not touch upon that city. They fall within one zone, requiring

only one zone ticket; but if Buda-Pesth must be passed two tickets are required—that is to say, if a passenger wishes to start from any given point to any other point leading through and beyond Buda-Pesth, he is obliged to take one ticket in order to reach Buda-Pesth and another to take him from that city to his place of destination. Although at the time of the introduction of the zone tariff the number of passengers carried over the 3,400 miles of Hungarian State railways remained considerably behind the number carried during the corresponding period of the preceding year, this number increased at such a rate that, according to official statistics there, were sold during the month of November, 1889, 947,669 passenger tickets yielding a revenue of 710,293 florins, while for November, 1888, 503,649 tickets were sold realising 595,133 florins, thus showing an increase of 444,020 passengers and 155,165 florins. The success of the zone tariff is not confined to the year immediately following the introduction of that system, but the period from August 1st to September 20th, 1890, shows another increase of passengers to the number of 475,578, and an increase of receipts to the extent of 56,078 florins compared with the corresponding period of 1889. For goods traffic a similar reform has been worked out by the Hungarian Minister of Commerce. By this system, three zones of distances are established for the carriage of goods (1) from 1 to 200 kilometres (·621 of a mile to 124 miles); (2) from 125 miles to 250 miles; (3) 251 miles and over. For each of these zones a uniform tariff is fixed, which is less by 33 per cent. than the former average tariff for the conveyance of goods. The returns from Hungarian railway shares are somewhat lower than from those of the Austrian lines. The Hungarian Government however is, says Consul-General Goldschmidt, rapidly taking possession of the private lines or those owned and worked by companies. The State has already acquired the Buda-Pesth-Fünfkirchen Railway, and is carrying on negotiations for the acquisition of several other private lines.

CULTIVATION OF ORANGES IN INDIA.

It appears from a report by the lecturer on botany and agriculture, at the College of Science, Poona, that the best oranges grown for profit in India is the "Cintra," a name commonly assumed to be derived from the Portuguese town, but lately declared to be a corruption of a Sanskrit word, which should be pronounced "Suntura." The tree which bears this fruit is of upright growth, and rarely exceeding twelve feet in height and eight in expansion. The fruit is of two varieties, one having the skin remarkably loose and the other having a smooth tight-fitting skin. As grown at Nágpur, this has been declared, by people who have travelled much, to be the finest orange grown in the world. The inner skin is very delicate, and the liths (carpels) so slightly

cohering that it is easy to break up for eating. Well grown specimens have only two or three seeds. The flavour of the two varieties is equal if grown under similar conditions, but the loose skinned variety has a better appearance, and is rather more easily peeled. Ordinary market specimens of the fruit average eight ounces in weight, but ten ounce specimens are common. The Mozambique orange tree is a distinct species, producing an irregularly globular head. Average specimens of the fruit of this tree grown in India attain a weight of eight ounces. In shape it is globular, slightly compressed vertically; the skin is of medium thickness, tight-fitting, and marked by numerous small vertical furrows, and a circular smooth mark, about an inch in diameter, on the upper end. The pulp is usually pale yellow, but when dead ripe becomes of the brownish yellow that may be called the medium tint of orange pulp. In flavour it is sweet, but without the piquancy of the best varieties. The Ladoo orange of the Deccan attains about eight ounces in weight, is in shape a much depressed globe, with a distinct nipple at the stalk, and within the skin, at the upper end, generally has an extra orange, about three-quarters of an inch in diameter. The skin is of a dusky yellow colour, but on account of its indifferent appearance, this kind of orange does not fetch a high price. The La'll Ladoo orange of the Deccan has been identified with the Mandarin orange. The skin of the fruit is a deep orange colour, smooth, loose, and having a strong inner skin. The Cowla orange is a small-sized, indifferent fruit, which becomes yellow on the tree before it is sweet. The Sylhet orange, which is common in the Calcutta market, is grown in the country whose name it bears. It averages about five ounces in weight, and is of good flavour. The Malta and St. Michael's oranges have been introduced, but are not making progress wherever it is possible to grow the "Cintra." The finest oranges in India—and, in the opinion of some, in the world—are grown near Nágpur, which lies at an altitude of 1,025 feet above the sea-level. The orchards are fully exposed to the sun and on level ground, having a dark-coloured, stiff, loamy soil, not less than three feet in depth. The climate of Nágpur may be described as comparatively hot and moist from June to September, cool and dry from October to February, and hot and dry from March to May. There are two distinct seasons in which the trees will flower and ripen fruit; and to obtain high-class fruit, the grower must select which season he will work, as the trees will not bear properly at both seasons. The finest fruit is obtained from flowers that open in June-July, and is on the market from February to May; the second flowering is in February-March; this fruit ripens from December to February. The trees are kept dry during May or December, according to the season at which fruit is wanted; at other seasons, irrigation is carried on to such an extent as to provide, with the rainfall, at least four inches of water over

the entire surface each month. The irrigation water is drawn from wells of about 30 feet in depth, by means of a leather bucket, containing about 25 gallons, which is drawn up by bullocks. The water is turned into small surface channels. One channel serves two lines of trees, and from it the water is passed into sunk beds round the stem of the tree, extending as far as the sweep of the branches. The soil is kept clean and open on the surface by ploughing four inches deep three times yearly. For the crop that ripens during February, March-April, water is withheld, the soil is opened up during April-May, and the roots exposed during 15 days, so that the trees get a check sufficient to cause the greater part of the leaves to fall. Then about 100 pounds weight per tree of old moist cowdung is mixed with the soil, and the roots covered up and watered heavily, if rain does not fall soon. The same operation, carried out in December, brings ripe fruit during December, January, and February. The trees are planted about 12 feet apart each way.

THE LIQUORICE PLANT IN TURKEY.

Her Majesty's Consul at Bussorah, in his last report, says that the great rivers of the Tigris and Euphrates, in the part where the liquorice root is found, flow through flat, treeless prairies of uncultivated and nearly uninhabited land, capable, with irrigation, of producing any grain. For three months of the year, hot winds blow, and the temperature reaches 104 degrees. For six months, the climate is moderate and salubrious, and for three months bleak and wintry, the thermometer going down to 30 degrees at night. The liquorice plant is a small shrub, with light foliage, growing to about three feet high, invariably where its root can reach the water. It grows without any cultivation. No lands are leased for the purpose, and no objection is made to its being collected. It is found in abundance from Ctesiphon, 20 miles from Baghdad, down to Kut-ul-Anara, the latter place being half-way between the ports of Bussorah and Baghdad. It grows on red earth soil, and also on light, almost sandy, soil, where the wood is best, provided it has plenty of water, and the ground is not more than 50 yards from the actual river or stream. The plant is dug up by Arab labour, which is generally plentiful, and the men can be brought by boat to the place where the plant is growing. They are paid according to the quantity dug. The wood, after being dug up and cut, grows again better afterwards. The time of collecting is, generally speaking, during the winter, but it is possible all the year round. The root, when dug, is full of water, and must be allowed to dry. This process takes the greater part of a year, especially in hot weather. After it is dry, or during the process, it is sawn or cut into small pieces six inches to a foot long. The good and sound pieces

are kept, and the rotten pieces are used for firewood. A local tax of 10 per cent. is claimed by the Government—which may be taken in money or kind—from roots taken from the Sultan's lands, and 20 per cent. from Government lands. It is shipped in river native boats for Bussorah, where there is a wool hydraulic press; and is afterwards shipped in pressed bales to London, and again transhipped to America, where it is largely used in the manufacture of tobacco. The trade, says Consul Chenevix-Trench, is capable of expansion, the demand in America is great, and shipments are easily disposed of.

APPLICATIONS OF CORK.

The utilisation of cork has, of late years, been developed in a variety of ways, one of the most important being that for linoleum, and, more recently, for the so called corticine for covering floors.

At the French Exhibition, at Earl's court, last year, an application of the bark of *Quercus suber* was shown under the name of "Subirine." The substance consists of pulverised cork of different degrees of fineness, known as impalpable, fine, medium, and coarse; the pulverisation being effected by means of a horizontal grindstone. The powder called impalpable is practically the finest that has yet been obtained. It will sift through a metallic tissue having 140 wires to the French square inch. This powder is said to be used in pharmacy, perfumery, the manufacture of india-rubber compositions, and in various other trades and manufactures. The fine powders are employed to pack eggs, fruit, vegetables, &c.

A striking use of these cork powders, however, is for the composition of a patented substance called Liégine, which consists of the powdered cork mixed with fine plaster in the proportion of 10 per cent. From this mouldings are made, which are said to be much superior to the ordinary plaster mouldings in appearance, and having the recommendation of greater solidity, durability, and lightness; so that Liégine mouldings can be put on thin partitions and on ceilings of a large size, without any overburdening. Its colour is similar to that of terra-cotta, and may advantageously take its place, saving thereby the cost of baking, and avoiding warping, shrinking, and breakage, which are such grave inconveniences in the manufacture and use of terra-cotta. The medium powders are employed in the French navy and by navigation companies for painting the sheet iron and partitions of the insides of vessels. These coatings are said considerably to diminish the conductivity of the sheet iron, and the vibrations so unpleasant, which are produced directly the sea becomes a little rough.

The Liégine composition is produced, in all shapes and sizes, in the form of light bricks, which can be used as concrete for covering buildings, as a protec-

tion from heat or cold, or for partitions, roofs, lofts, ceilings, and coatings of all kinds; as packing for boilers, ice-houses, conservatories, coverings of wagons, steam-pipes, &c.; in short, in every case where it is desirable to maintain an equal temperature. By means of frames filled with Liçine, panels can be made suitable for the construction of houses, which may be taken to pieces, and removed when required. As a protection from damp, also, this substance, it is said, will prove most valuable. Samples of this new application of cork are shown in the Museum of the Royal Gardens, Kew.

Correspondence.

THE "TUGHRA" OF THE TURKS.

Several letters having been addressed to me with reference to Mr. Hyde Clarke's and my notes, in the *Journal of the Society of Arts*, at pp. 809 and 822, on the *tughra* or *toghra* of the Sultans of Turkey, I placed myself in communication with a learned Arab of Syria and some Turkish gentlemen on the subject. I have been pained to find them less informed on it than Mr. Hyde Clarke and myself. I say pained, for, with their ever increasing Europeanisation, this ignorance of everything that relates to themselves—even of their religion—is becoming more and more characteristic of "educated Asiatics" everywhere. But still my courteous correspondents have afforded me some fresh items, which I send for the Society's *Journal* in order that it may contain all that has hitherto been published in English about the matter.

Mr. William Simpson enquired whether it was the fact, as he had been told, that the earlier Sultans, when they ratified a treaty, sacrificed a sheep, and dipping their right hand into the blood, impressed the same on the document to be signed by them. My correspondents never before heard of this version of the origin of the *tughra*, and regard it as incredible. It is incredible of any orthodox Mahomedans, and is probably historically untrue. One of my correspondents adds:—"There are special clerks, under the *nishanji bashi*, who inscribe the *toughras*, and there is a special bureau for them at the Porte, called the *divan humayoun*." It appears also that, although the official correspondence of the Porte is written in the so-called *divani* style of Oriental chirography, the *tughra*, and the formula attesting it, are in the *jari* style. The formula translated reads thus:—"This is the pure, high, and shining *sign-manual* and the world-inspiring *cypher* of the Great Khan [by the grace of God may it fulfil its purpose]. His order is as follows:—"

The only reference to the *tughra* of the Sultans I have found in English literature is in Marlowe's

"Tamburlaine the Great," Act I., Scene 2, where Zenocrate, addressing Tamburlaine, says of herself:—

"Who travelling with these Median lords
To Memphis, from my uncle's country of Media,
Where, all my youth, I have been governèd,
Have passed the army of the mighty Turk [Bajazet],
Bearing his privy signet [*secretum*] and his hand ["sign-manual," or *tughra* proper],
To safe-conduct us through Africa."

Tughra means, literally, "flourish"—the "flourish of the Turk," and is, I suppose, connected with *tughrana*, "to twist in and out," and "round about," after the manner of young people dancing. Mr. Hyde Clarke alludes to the apotelesmatic character of seals. In the East they have always been regarded as talismans, and now, everywhere, in Anterior Asia, in the true astrological sense of the term. But in India their magical virtues are also founded on phallic associations; and in the earliest times all seals were probably phallic emblems. This is borne out by the analogy of the *fascinum* of the Romans, the *lingam* ornament of the "Lingâets" of India, and the "male images"—the "ornament of ornaments"—worn by the women of ancient Jerusalem (Ezekiel xvi. 17); and the presumption serves to explain why, to this day, throughout the East, the signet seal is regarded as of higher authenticity than a signatory's own written signature. In Turkey the signet seal is, *effendi* (*authentès*, i.e., literally, "one who does any thing with his own hand"!) himself; just as in India, the *lingam* seal, being the most sacred symbol of its owner's family and individual personality, is therefore, and expressly, the supreme attestation of any diplomatic act and deed of his. No Eastern signet would ever bear such a circumscription as our Western ones sometimes do:—"This is the seal of John Brown." If any, it would be, as on many Greek seals:—"I am [emphatically] John Brown." These signet seals of the East have also attributed to them an apotroptic or averruncal power, directly derived from that of specific talismanic seals and other amulets; and the Mahomedans not being allowed to represent the human or animal forms in art, frequently in India, and doubtless elsewhere, take advantage of the *tughra*, or flourished style of writing, to give signatures graven on their seals some semblance to the fierce features of Kali, the terrible consort of Siva, or of the "snaky Medusa," and other dire Gorgonic types; reminding one of the grim head to be sometimes seen on the back of the daily newspapers, advertising a London school of "shorthand" writing. The portentous Medusa mask, obviously of Oriental origin, already appears on Greek cameos so far back as the 6th century B.C.; and the big pectoral boss on the cuirass of Roman generals and emperors was fashioned in its similitude, whether copied directly from the ægis of Athene, as rendered in Greek sculpture, or indirectly imitated from it through the cuirass, or the shield, of the Macedonian Greeks.

GEORGE BIRDWOOD.

Sept. 21, 1891.

Journal of the Society of Arts.

No. 2,028. VOL. XXXIX.

FRIDAY, OCTOBER 2, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a prize for £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competitions held in 1892 and in 1893.

The prize is offered to the student who obtains the highest marks in the following stages of instruction:—

A finished drawing of imperial size from the nude living model.

Time studies from the nude living model.

Studies of hand and feet from the living model.

Also, in the 3rd Grade Examination, May, 1892, in drawing from the living model.

No student will be eligible for the award who has not taken a First-class at the Third Grade Examination, and who has not received marks for a drawing of imperial size. Neither of the other two subjects is obligatory, but a fair proportion of marks will be given for each.

The works must be those of the previous school year.

The drawings, &c., are to be submitted in the usual manner to the Examiners, at the Annual Competition (April, 1892) of the Department of Science and Art. Competing drawings, &c., must be marked, "In Competition for the Mulready Prize," in addition to being labelled and staged according to the regulations of the Department of Science and Art.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a Prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual National Competition held in 1892.

The prize is offered for the best original design for architectural decoration, by means of painting, stucco, carving, mosaic, or any other method, such as that for the side of a room or hall, a ceiling, or the apse or side of the chancel of a church. The design must be on imperial sheets, and must be accompanied by drawings of details on separate imperial sheets. Mere patterns or pieces of painting and modelling, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The work is to be that of the previous school year.

The designs are to be submitted in the usual manner to the Examiners, at the Annual Competition (April, 1892) of the Department of Science and Art. Competing designs must be marked, "In competition for the Stock Prize," in addition to being labelled and staged according to the regulations of the Department of Science and Art.

Chicago Exhibition, 1893.

Forms of application for space, and prospectuses with detailed information, will not be issued till later in the month, but, in the meantime, intending exhibitors can apply to the Secretary of the Royal Commission, and their names will be noted at once, with a view to their receiving early copies of the prospectus when ready.

A few copies of the Regulations for Foreign Exhibitors, and Rules for the Department of Fine Arts, have been received, and copies may be obtained on application to the Secretary, John-street, Adelphi.

A movement has been set on foot at Bristol for the adequate representation at the Chicago Exhibition of the close connection of that city with the Cabots, the discoverers of the mainland of North America in 1497, a year before Columbus discovered South America, and five years after he discovered the West

Indies in 1492, which is the date commemorated by the Columbian Exhibition. Bristol was the home of John Cabot for many years, and his distinguished son, Sebastian Cabot, was born there. Although these discoverers received little support from the King, they were heartily encouraged by the merchants of Bristol, who risked much in their support. It has been suggested that the exhibit from Bristol at Chicago should consist of a reproduction of Saint Peter's Hospital, Bristol, a specimen of domestic architecture which dates partly from before the time of the Cabots, and partly from the period of the colonisation of Virginia; and also a model of the *Matthew*, the ship in which the Cabots sailed and made their discovery of the mainland of America.

Miscellaneous.

GUTTA-PERCHA TREE AT SINGAPORE.

The September number of the *Bulletin of the Royal Gardens, Kew*, has the following account of the continued existence in the island of Singapore of the original species of gutta-percha tree (*Dichopsis gutta*, Benth.), originally described as *Isonandra gutta*, Hook., from which gutta-percha was first obtained, which is abstracted from a note by M. Sérullas in the *Paris Comptes Rendus*:—

"The existence of gutta-percha was announced to the civilised world in 1842 by Dr. W. Montgomerie. The priority in this respect of the traveller Tradescant has not been established. In any case the first specimens which reached Europe under the name, coming from Singapore, were brought to London in April, 1843, by Sir José d'Almeida.

"In bringing to light their remarkable properties, no time was lost by Hancock. Wheatstone, moreover, who had been speculating since 1837 on a telegraphic union between England and the Continent, conceived the idea of employing them for this purpose, but it was not until the 10th of January, 1849, that a submarine cable was first sunk by Mr. Walker in the English Channel. This cable, whose length, however, was only two miles starting from Folkestone beach, was sheathed with gutta-percha.

"Since that time numerous attempts have been made to replace gutta-percha for this purpose, now that the demand is so great, and it is constantly becoming more scarce and dearer every year. Hitherto they have all failed. The fact is that submarine telegraphy requires gums of the finest quality. Those of *Bassia Parkii* from Africa, and of *Mimusops Balata* from the Guianas, have only given negative

results. As for that of *Payena Leeveii* (Gutta Sundek), if it is in actual use to-day it is simply owing to mistake on the part of the collectors.

"The only gums which are of use as insulators for cables, are produced by trees of the genus *Isonandra* (now sunk in *Dichopsis*). Their natural habitat is exclusively in the Malayan region.

"The destruction of the interesting zone of Malay forests proceeds rapidly. The natives cut every available tree and repeat the process as fast as they spring up again; they have thus suppressed for the last forty years their reproduction and multiplication.

"Such gums as those used at the commencement of the industry are those no longer met with except in exceptional cases. Those which have replaced them will share the same fate within the next fifty years. Little by little the exportations are beginning to cease from the Malay ports. The scanty plantations started in the East Indies are, moreover, formed not of the better species, but of those which, though rich in latex, yield an inferior product. Submarine telegraphy, in point of fact, is on the eve of finding itself destitute of those plants which are indispensable to it in the present state of science, yet the source of these guttas is still imperfectly understood.

"Historically, the first plant described as a source of gutta-percha was *Isonandra gutta*, Hooker. This is the only tree of which the coagulated latex, when sent to Europe, has stood the test of practice. It is described as extinct since 1857 in the island of Singapore, and as existing only in the Malay forests.

"In point of fact, this species has become excessively rare, but it is still in existence. Its adult representatives were still propagating themselves in 1887 at Chasseriau estate in the ravines of the ancient forest of Boukett Timah, situated in the centre of Singapore, where it was discovered in 1847 by Mr. Thomas Lobb, who collected on the spot the specimens preserved in the Kew Herbarium. Except Dr. Oxley, no one has since succeeded in obtaining it. The tree only flowers when thirty years old, and at intervals of two years. When I found it in 1887 any gutta collecting had ceased for the last thirty years. The extinction of the tree was supposed to be complete. Nevertheless, hardly three years ago there still existed in the remnants of the ancient forests of the island adult trees of this species, represented chiefly by offshoots.

"The word 'gutta' in the Malay language is only used in the absolutely general sense of 'gum' or 'glue.' The word 'percha' does not mean merely 'Sumatra' as has hitherto been generally believed (Sumatra is called 'perxa,' which means the inhabited terrestrial world). Percha means 'rag,' and exactly characterises the appearance of the gums, which before treatment with warm water resemble rags half reduced to compressed paper-pulp.

"In the Malay forests, in which I travelled for four years, I met with only five kinds of trees which could be mistaken at first sight for *I. Gutta* from their foliage, and from having a similar latex. It is impossible to confuse it with the other species of

Isonandra which produce gutta of different quality, Gutta Sundek in this respect being intermediate.

"The Gutta Sundek of commerce is evidently a complex mixture."

Dr. Montgomerie sent specimens from Singapore to the Society of Arts in 1843. These specimens are described as follows in the minutes of the Society's Committee for November 30th, 1843:—"1. Bottle of the juice. 2. Thin sheets resembling scraps of leather. 3. A spongy mass as it concretes in a vessel. 4. Substance formed into masses by agglutinating the thin sheets by means of hot water."

In 1845, the Gold Medal of the Society was awarded to Dr. Montgomerie, "for the introduction of a substance called gutta-percha from Singapore."

AGRICULTURAL CREDIT INSTITUTIONS IN AUSTRIA.

The United States Consul at Reichenberg says in his last report, that one great cause of agricultural distress in Austria is to be attributed to the limited scope of agricultural credit conditions. Credit has not, in most cases, the characteristics which the Austrian farmer, by virtue of his importance, should demand. The rate of interest depends upon the condition of the market, and reaches, on account of demand fostered by speculation, a height which no estate can bear. The researches of the Central Statistical Commission during the last year, show that registered debts secured by real estate amount in those districts where a registry system exists, such as Bohemia, Silesia, and Moravia, Upper and Lower Austria, Styria, &c., to 3,062,000,000 florins, while small estates alone are indebted to the amount of 2,000,000,000 florins, paying as high as 12 per cent., while the larger sums pay 5 and 6 per cent. When it is considered that rents are continually falling and that Austrian estates in very good districts produce only an earning of 3 to 5 per cent. on an average, it can be seen that the land cannot support so high a rate of interest. In order that agricultural credit may really aid the farmer it must (1) be cheap, so that the interest bears a proper relation to production; (2) there must be a fixed rate of interest, uninfluenced by speculation, based entirely upon the rent of the property, if rented; and (3) the principal should not be demanded so long as payments are promptly made and interest paid up. In regard to the various banking institutions of Austria these have more connection with manufacture than with agriculture, and the Vienna, Prague, and Buda-Pesth banks devote themselves almost exclusively to industry and trade. Two great institutions—the Hypothekenbank of the kingdom of Bohemia, and the Landwirthschaftlichen Credit Bank—occupy themselves with transactions with large agricultural estates. The loans made by the first of these banks are not made in cash but by issuing their own bonds, which are known as *pfandbriefe*. The whole amount

of such bonds in circulation must not exceed the amount of actual loans. The rate of interest of mortgage bonds is from 4 to 5 per cent., and is equal to the interest on the mortgage for which the bonds have been issued. Every year it is determined by chance what proportion of these bonds must be cashed. The Government is responsible for the claims of holders of bonds, according to the statutes. As the deeds are dealt in "on change," they offer excellent investment for capital. The holders of such bonds can at any time sell their claims on the bank. The extent of 4 and 5 per cent. *pfandbriefe* amounts at present to about 100,000,000 florins. The Landwirthschaftlichen Credit Bank does a commission business, helps especially the export of sugar, grants credits, and gives certificates in amounts of 100, 500, 1,000, and 5,000 florins. The capital amounts to 2,000,000 florins, divided into 10,000 shares of 200 florins each, of which 100 florins each are paid up. The fund can, however, with the consent of the Government, in case of need be raised to 12,000,000 gulden. The connection which the bank has with agriculture is the quantity of loans secured by mortgage, liens on crops, implements, &c., and the insurance of machinery, implements, and animals. The bank is also empowered to aid economical undertakings, especially those for the improvement of the land. In regard to the length of credit, personal credit is granted for indefinite periods, and secured credit only for fixed periods, never longer than three years. The enjoyment of an open credit can only take place when the applicant has deposited a sum amounting to 5 per cent. in cash of the credit granted in the general safety fund and given the necessary securities. With secured loans this payment is omitted. The value of real estate about to be mortgaged is usually fixed by the amount produced by the land and soil. Twenty times this yearly amount will be advanced. Far more than these great banks, and operating much more advantageously for the small landowner, are the savings and advance funds (*Spar und Voorschusskassen*) and the Agricultural Credit and Partnership Association (*Landwirthschaftlichen Credit und Genossenschafts Verein*), and these require a much lower rate of interest. The agricultural associations, which arise from the union of a number of landowners, accomplish very important work; and wherever they have been established they have succeeded. These accomplish definite undertakings; for instance, for the regulation of streams in one or two communities, a *Wassergenossenschaft* will be founded; for the drainage of fields and meadows of an entire district, a *Drainagenossenschaft*; or one for the procuring of implements, machines, and other articles needed for agricultural purposes, which are bought wholesale, and delivered to members at less cost than the retail prices. In the last four years a very effective agency in agricultural credit conditions has been developed, in the shape of a loan association, which is being yearly extended. The "Country Savings

and Loan Fund Association" has for its object the moral and material improvement of its members, the granting of loans to members under a general guarantee, as well as the employment of such unemployed capital as is not needed. The objects of the society, succinctly stated, are—(1) To furnish its members with money for agricultural purposes, in proportion to their credit and reliability, under a general guarantee; (2) to accept deposits of unemployed capital; and (3) the creation of profitable and economical partnerships in the district of the association. Only responsible owners, lessors, or holders of land in the district, who are in full enjoyment of their rights of citizenship, and who are not members of any other credit association, are admitted to membership. The society must be informed, with each application for a loan, of the use to be made of the money; and the officers of the society are required to watch that such loans are only used for agricultural purposes, and in the manner proposed. The length of the period for which the loan is granted depends upon the purpose for which it is made; and any improper use of the money gives the society the right to demand and recover the amount at once. Every member is entitled to a loan not exceeding the maximum amount, usually 1,000 to 1,500 florins. These loans usually pay an interest of half per cent. higher than the association allows on deposits. According to the Statutes of Lower Austria, in no case can the interest on loans be more than $1\frac{1}{2}$ per cent. greater than on deposits.

SWISS WATCH-MAKING INDUSTRY.

A correspondent of the *Economiste Français*, who has long been resident in the Bernese Jura, gives the following information with regard to the watch-making industry of Switzerland:—

It is in the west of Switzerland, where the French language is spoken, that the watch industry is chiefly to be found. Four distinct centres are at the present time occupied by thousands of the workmen's families:—Geneva, Vaud, the canton of Neuchâtel, and the Bernese Jura.

In the 19th century it is the Bernese Jura which has largely developed the watch industry. Everywhere, in the mountains and valleys, watch-making introduced at the end of the 18th century by the Neuchatelese, is taking a more prominent position, and three industrial centres are growing up in Bienne, St. Imier, and Porrentruy.

If chance has brought into the west of Switzerland the first watchmakers, the latter found there, to assist them in establishing their industry, an excellently prepared centre.

These mountain countries were poor; no industrial or artistic feature was found there; emigration, as in the Oberland, Valais, and the Grisons, was a traditional custom. Small domestic workshops for watchmaking were established, where the members

of the family found in the long winter months a remunerative employment, while they kept in the summer to the rearing of cattle and to the cultivation of the land. The peasants hailed with joy this method of adding to their incomes, which in no sense modified their old habits, and secured them a greater amount of material ease and well-being; thenceforth emigration to foreign countries was no longer necessary for the Swiss; they devoted themselves to industry. It should be noted, moreover, that the watch industry requires little capital. Factories are not made use of; the carriage of the light product was rendered easy owing to the perfect organisation of the Swiss posts, which serve the highest mountains. Markets have been open on all sides since the commencement of the 19th century.

At that time sprang up an ingenious labour organisation, combining at one and the same time the advantages of principal and minor industry. Composed of small workshops, grouped in a given region, it is under the control of a manufacturer who gives orders to the workman, supplies him with the necessary materials, and, when the watch is finished, effects a sale. Under this system the master has not the general expenses of a factory, and the diminution in production and holidays affect him but little. In his turn, the workman working at home has a particular part of the watch to work upon, either the watch case or detached pieces. The workman is both journeyman and foreman who combines his dwelling with his workshop. Paid by piecework, he works at his leisure from early in the morning to late at night; and Art. 11 of the federal law of the 23rd March, 1877, cannot be applied to him. "The regular duration of a working day must not exceed 11 hours. This duration must be comprised between 11 a.m. and 8 p.m. during the months of June, July, and August, and between 6 a.m. and 8 p.m. during the remainder of the year." Such a system, which allows the wife to assist in the work of the husband, and the children to be initiated by an easy apprenticeship into the manufacture of a special part of the watch, must suit the mountaineers of the district of Neuchâtel and the Bernese Jura. They preserve their intelligence, realise often large profits, and by the intelligent practice of industrial art, improve their social status.

Little by little the heads of business houses have drawn into their locality a large number of families from the rural districts, and in the mountains, at 1,000 metres altitude, and on the plains where only the abundant pasturage affords a means of livelihood for the native, towns have risen rapidly, such as Chaux de Fonds, Locle, and St. Imier.

Thus the system of collective industry, with work at the domestic hearth, has formed several generations of watchmakers. But, for thirty years, competition, and particularly American competition, has necessitated the erection of works with mechanical appliances. Objections were raised by certain persons to the work in houses and small

workshops, to the want of unity, of exactness and of uniformity in the manufacture of pieces of the same kind; some pointed to a very great inferiority in the division of labour; others asserted that the home watch-making industry, notwithstanding the traditional qualities of the workman, would make no advance; many point, not unreasonably, to the high price of skilled labour. At the Philadelphia Exhibition in 1876, the Swiss delegate to that Exhibition, M. Gribi, illustrating the constant improvement of American watch-making, reported as follows:—"It is the result of their system of manufacture, which allows of a rigorous and constant superintendence, carried out up to the minor details, as much in the construction of their tools as in the making of the watches. If apprenticeship has cost the Americans dearly, the experience which they have acquired is now worth to them hundreds of thousands of dollars. It is this experience which enables them to compete with us, and which we shall not acquire so long as we preserve the principles which are the basis of our system of manufacture, that is to say, home industry."

Since then the manufacturers in the western districts of Switzerland have gradually substituted work in factories for work in the small workshop. Factories have been built, provided with improved machinery, the immediate result of which has been the diminution in cost price and the development of consumption. While maintaining the manufacture of watches of precision, chronometers, and complicated pieces, they have bestowed considerable attention to the making of ordinary watches of good quality; and, at the time of the Universal Exhibition of 1889, the reporter of Class 26, M. Cesar Brandt, Member of the International Jury, wrote:—"The Paris Exhibition has shown that Switzerland is in the front rank in this class of watch-making, and that she has made the greatest progress with the ordinary watch. This progress is due chiefly: (1) to the factories making the whole watch by mechanical processes; (2) to the factories forming a syndicate, which has resulted in the production of an improved article;" and he cited, as a proof of this progress, two well-known establishments in Jura—the Francillon factory of St. Imier, and the Dubail-Monnin-Frossard factory of Porrentruy.

The transformation of the means of production and the work in factory, whilst leaving a very important place in the work of the small workshop, have hitherto secured to the Swiss watchmakers a regular and satisfactory remuneration, notwithstanding active competition, which has entailed, within 20 years, a diminution in wages from 15 to 20 per cent., at the same time that the price of the watch has fallen by from 40 to 50 per cent.

If Swiss watch-making has been able, in spite of passing crises, to maintain its traditional renown, to improve its plant, keep its place on the markets in England, Germany, Austria, Russia, Italy, Belgium, Holland, and even in France and the United States,

where competition is keen, it owes it to the bold initiative of the masters, seconded by the intelligence and skill of the workmen.

The watch-making schools of Geneva, Neuchâtel, Chaux de Fonds, Locle, Fleurier, Bienne, St. Imier, and Porrentruy; the observatories; the numerous manufacturing societies, and the trade journals have all contributed to the progress of this industry.

The value of the total exports of watches from Switzerland in 1890 exceeded the sum of £4,000,000.

The workman, by quitting the fields for the urban factories, loses several advantages, among others cheapness of living, real independence; but at any rate he receives regular wages. Fortunately for him the chief industries have developed quietly and by degrees, still leaving some room for domestic labour. Thus the relations between masters and workmen have not been strained hitherto, and federal legislation, which protects the worker very effectually, has prevented abuses. The only thing which has been noticed is in regard to the payment of wages, and in particular to the watch-making industry. A number of manufacturers have been accustomed to retain, under the peculiar name of *discount*, a sum of 5 per cent. on the wages paid each month to their workmen. Denounced at the Workmen's Congress at Olten, in April, 1890, this practice was immediately abandoned by the principal manufacturers, and, little by little, under the pressure of the workmen, it will come into disuse.

The Swiss watchmaker has made for himself, by his knowledge, his professional skill, and his relatively high wage, an exceptional position in the working world. Paid by piece-work, he gets the same, whether in the factory or at home. He works, generally, without engagement; but the tacit contract, concluded with his master, cannot be broken without notice on either side, which is often 14 days. Several families show a monthly gain of from £12 to £16, and, as the cost of living is in Switzerland much less than in the manufacturing centres of France, Germany, and England, it may be safely concluded that comfortable living is easily obtained. Such would almost always be the case, if drink were not the supreme enjoyment in these mountainous districts, and if it did not consume a very large part of the wages. Owing to societies which have been formed in Switzerland, the workman finds support in case of illness, accidents, or idleness. Co-operative stores and boarding houses, cheap restaurants, and savings banks are present in large numbers.—*Board of Trade Journal*.

COLOUR TESTS.

A report for the year ending May 31 last, by Mr. G. J. Swanston, the Assistant Secretary of the Marine Department of the Board of Trade, upon the colour tests used in the examination of candidates for masters' and mates' certificates in the British

mercantile marine, has been issued as a Parliamentary paper.

The report is as follows :—

The usual statistical Tables for the year ending May 31 last, relative to the examination in colours of candidates for masters' and mates' certificates of competency, and other persons belonging to the mercantile marine, are herewith submitted.

The number of persons who presented themselves for examination for masters' and mates' certificates of competency under Form "Examination 2" amounted to 4,688, being an increase of 26 over the previous year, when 4,662 were examined. In the past year 31 persons were rejected for their inability to distinguish colours, as compared with 23 rejected in the previous year.

The number of persons examined in colours only, under Form "Examination 2a," amounted to 601, of which 32 were rejected, being an increase of over 1·8 per cent., as compared with the previous year, when out of 839 candidates examined, 29 were rejected.

The mode of conducting the colour test examination described in the report for the year 1887 is still in operation, but, as I mentioned in my remarks of last year, the whole subject of colour vision and the best mode of conducting the examinations are now under investigation by a committee appointed by the Royal Society. It is not probable that their report will be presented until next year.

Appended to the report is a list of the candidates who failed to pass. Some few among them succeeded in satisfying the examiners at a later date than the date mentioned. One man, who, on March 3, described a green card as drab, drab as green, pink glass as salmon and green, standard green as blue, bottle green as red, and neutral as green, passed a fortnight later, having apparently learned to distinguish the colours in the intervening period.

Also appended is two Tables showing the number and nature of the mistakes made by the rejected candidates :—

TABLE I.

Colours of Cards.	White.	Black.	Red.	Pink.	Green.	Drab.	Blue.	Yellow.	Other Colours.
White, described as..	—	—	—	1	—	—	—	—	13
*Black „ „ ..	—	—	4	1	16	1	—	—	12
*Red „ „ ..	—	—	—	—	21	—	—	—	11
Pink „ „ ..	1	—	17	—	166	32	12	—	34
*Green „ „ ..	32	—	28	42	—	33	—	4	32
Drab „ „ ..	7	—	2	64	205	—	—	4	40
Blue „ „ ..	—	—	—	—	—	—	—	—	—
Yellow „ „ ..	4	—	1	—	1	3	—	—	3

TABLE II.

Colours of Glasses.	Ground.	Red.	Pink.	Green.	Pale Green.	Yellow.	Neutral.	Blue.	Pale Blue.	White.	Other Colours
*Ground, described as.	—	3	1	1	—	1	—	—	—	163	31
*Standard Red „	—	—	1	67	—	18	2	—	—	—	10
Pink „	—	177	—	90	—	179	6	3	—	7	80
*Standard Green „	—	35	7	—	10	1	23	85	9	8	16
Bottle „	—	391	7	—	4	28	8	8	2	8	30
Pale „	—	125	7	—	—	92	15	4	5	52	31
Yellow „	—	204	2	39	3	—	1	—	—	9	48
Neutral „	—	51	2	324	3	19	—	4	10	5	36
Blue „	—	1	29	140	3	—	—	—	2	1	8
Pale Blue „	—	1	2	287	14	—	—	—	—	72	12
White „	—	—	—	—	—	—	—	—	—	—	—

* Colours for failure in distinguishing which the Board of Trade reject candidates.

SIR JOHN HILL AND THE SOCIETY OF ARTS.

Dr. John Hill, who having received in 1774 the Swedish Order of Vasa, as a reward for the publication of his large work on Botany, styled himself Sir John Hill, was a most voluminous author, and the list of his works fills five and a half columns of the *Dictionary of National Biography*. He was anxious to place on the title-pages of these works a list of the honours which he had received, but he was not held in much esteem by those he had dealings with, and when he was brought forward for the Fellowship of the Royal Society he was blackballed. The same ill-fate followed him when his name was submitted to the Society of Arts, on November 5th, 1760. He obtained his diploma of medicine from the University of St. Andrew, but, with this exception, he was obliged to content himself with such honours as he received from abroad. Hill, who was then "Mr. John Hill, apothecary," presented two papers to the Royal Society, one "On the Manner of the Seeding of Mosses" (1746), and the other "On Windsor Loam" (1747), which were printed in the *Philosophical Transactions*; but although the Society accepted his papers, they would not agree to enrol his name on their list of Fellows, and he expended his wrath by publishing, in 1751, "A Review of the Works of the Royal Society," a volume in which he held up the *Philosophical Transactions* to ridicule, and which he dedicated in an ironical and insulting strain to Martin Folkes, President of the Society. Ten years afterwards he issued a small pamphlet of eighteen pages, entitled "Some Projects recommended to the Society for the Encouragement of Arts, Manufactures, and Commerce. By the Inspector, proposed F.R.S., proposed Member of the Society for the Encouragement of Arts, &c. London, 1761."

The title of "Inspector" Hill took from his having contributed a daily article, full of scandal, to the *London Advertiser and Literary Gazette*, under that name. He was less bitter against the Society of Arts than against the Royal Society, but he put the best face he could on his discomfiture in both cases, and declared that he did not resent the rejection. He addressed the Society as follows:—

"GENTLEMEN,—My vanity is not in the least mortified by the repulse I received, when I was proposed to be elected a member of your Society. Though I was rejected, the Ballot terminated to my honour. I solicited no votes, I entreated none of my friends to be present, yet I may affirm that almost everyone, who came not purposely to exclude me, voted in my favour. My opponents all came from one quarter to gratify their resentment. I forgive them freely; they had great provocation from me; for I had dragged into open light their ignorance and dulness, which had so long skulked under the veil of Science and Philosophy. You, gentlemen, have nothing to fear from my resentment. Your institution is so honourable to yourselves and beneficial to the Publick, that

it would be an invidious task to busy one's self in discovering small imperfections."

The pamphlet contains the statement of two projects—one is intended as a joke, and is set out in ridicule of the Society's premium list; but the other is evidently intended as earnest, for it is a proposal for employing Hill himself in an undertaking which much interested him. He proposed that the Society should "purchase a spot of ground about 20 acres, which you will convert into a botanic garden, the care and management of which I will undertake with a handsome gratuity. This spot should not be destined for the cultivation of exotics alone, but the medicinal herbs of our own country should here find a place. I doubt not but that some herb of native growth might be found a specific remedy for every disease incident to an English constitution."

Hill subsequently laid out gardens of his own at Bayswater, where he cultivated the plants from which he prepared his quack medicines; and the site is covered by the houses which now form Lancaster-gate. The specific remedies which he boasted of, such as the "essence of waterdock," "tincture of valerian," "pectoral balsam of honey," and "tincture of bardana," brought him a large amount of money; but he could not cure himself with them, for he is said to have died of gout, a disease for which he professed to have a sovereign remedy.

Posterity, as well as Hill's contemporaries, seems to have come to an agreement that Garrick's epigram contained only the sober truth—

"For physic and farces his equal there scarce is,
His farces are physic, his physic a farce is."

Of Hill's immense work, entitled "The Vegetable Kingdom," published in twenty-four folio volumes, 1761–1775, Mr. Daydon Jackson says it is both "cumbersome and useless" ("Guide to the Literature of Botany"); but Hill is entitled to some praise, for Mr. Jackson states that the first Linnean flora of Britain was due to Hill, "who arranged Dillenius's edition of Ray's 'Synopsis' in the order of Linneæus's system, but without altering the descriptive names."

It is strange that Hill should have been so much less indignant with the Society of Arts than with the Royal Society, for in the latter case he attacks the Society itself, while in the former it is only his enemies in its ranks that are attacked. Possibly he had some hopes of employment by the Society in the formation of the botanic garden.

THE SPONGE FISHERIES OF THE
LEVANT.

The *Journal de la Chambre de Commerce de Constantinople* says that it is in the islands under the jurisdiction of Rhodes, particularly at Symi, Halki, and Calymnos, that the sponge fishery is most extensively engaged in, and not at Rhodes itself,

owing to the fact that there are only two or three European shipowners there, owning among them about three or four "scaphandros," a species of diving apparatus. The number of scaphandros owned in the three islands above mentioned is about 300. Each scaphandro is attached to a vessel, and the vessels equipped for the fishery have a crew of 16 men, of whom five are divers, seven or eight sailors, one or two apprentices, and the master. In the whole of the islands of the Archipelago it is estimated there are about 1,000 boats. The owners of the scaphandros receive a third of the catch; shipowners receive a tenth; the master a varying proportion; and the crews receive in wages sums varying from £12 to £16. The tax levied by the Ottoman Government upon each vessel equipped with the diving apparatus amounts to the sum of 35 Turkish pounds; and for each boat, from which ordinary diving operations, without diving dress, is carried on, a sum of 12 Turkish pounds. The fishing season lasts six months, from May to October; and for this period a total product is reached of from seven to eight kilogrammes (kilogrammes = 2·204 lbs. avoirdupois) of sponges a day for each boat engaged. There is a considerable difference between the two operations of diving: with the scaphandro and without. The diver who is furnished with a scaphandro can remain under water for 40 minutes, and, consequently, has plenty of time to make a selection, and collect the sponges at his ease. The sponges, however, thus gathered have neither the good quality nor the size of those brought up by the other divers, owing to the fact that the man with the scaphandro cannot, without danger, go down to a depth exceeding 25 fathoms; and it frequently happens that the water to that particular depth has been fished before by the ordinary divers. A preference is entertained by the fishermen of the Archipelago for diving in the ordinary way, without the scaphandro; and this is practised in the following manner:—The diver is supplied with a cord, at the end of which he fixes a white flat stone, weighing about two kilogrammes, which helps him in his descent, and is a guide to him in the water. As soon as he reaches the bottom, he selects his sponges and places them in a net, which he carries suspended round his neck. Then, placing his naked feet upon the stone, he signals to his companion by means of the cord, of which he is careful not to relinquish his hold, that he is ready to come up. The depth at which experienced divers carry on their operations is from thirty to forty fathoms, and the time that they can remain under water is from two to three minutes. This depth will explain why sponges fished under these conditions are finer in texture and larger in size than those obtained by divers with the scaphandro. Moreover, in ordinary diving operations, if the man is perhaps less safe, he is certainly freer in his movements, and is the better able to conduct his search. The business in which he is engaged is, however, of a very exhaust-

ing nature. The amount realised by this industry represents annually a sum of nearly £350,000. The exports of sponges to Europe are effected in transit *via* Rhodes, Smyrna, and Syra. The freights on this article are somewhat high; for Trieste they amount to as much as fifteen francs the hundred kilogrammes. For the destination of France and the United Kingdom they vary between twenty-five and thirty francs the hundred kilogrammes. Sponges from the Ottoman Archipelago may be divided into three classes—those of superior quality, those which are large in size, and those which are inferior in quality, called *tchimoucha*. The first quality fetches an average price of about 8d. to 1s. 3d. a piece, and, by weight, they are sold at from 14s. to 25s. per pound. The price of the second quality varies according to the place in which it is found—between 6d. and 1s. a piece, and from 7s. to 9s. a pound. As regards the third quality—the *tchimoucha*—this is sold at prices varying between 1d. and 2d. a piece. The part taken in the sponge fishing industry by the principal islands, which are under the jurisdiction of Rhodes, is as follows:—Production of Halki, about 70 tons; Symi, 136 tons; Calymnos, 180 tons; and other islands about 44 tons. In 1890 the value of the exports was as follows:—Austria-Hungary, £84,000; United Kingdom, £44,000; Turkey, £4,000; and Egypt, £3,400.

ASBESTOS MINING IN CANADA.

The following information respecting the rapid development of the asbestos mining industry in portions of Canada, printed in the *Board of Trade Journal*, is taken from the *Empire*:—

Up to within a few years ago, by far the greater part of fine asbestos fibre adapted for spinning came from the mines of Italy and Corsica, and its price ranged from 250 dollars to 300 dollars a ton. The recent discovery of immense quantities of the valuable mineral in the province of Quebec has almost revolutionised the trade. The output of the Canadian mines, which are all comprised in a very small circuit, has increased from 50 tons, in 1871, to 8,000 tons in 1890, and prices have advanced, until, notwithstanding the largely increased production, the No. 1 Quebec asbestos now commands almost as good a price as the best Italian. This is not only due to the superior quality of the article, but to the variety of new uses to which it is applied, and which are increasing almost daily. The commoner grades continue, as before, to be manufactured into steam-packing and fireproof building felt.

Though it was known some decades ago that there was asbestos in the eastern townships, it was only a few years ago, when the burning of the forest in Thetford and Coleraine laid bare the hills of serpentine, that the abundance of the deposit was discovered. Now there has sprung up in each of those

townships populous mining villages containing 2,000 to 3,000 souls each, and large quantities of the product of the mines are almost daily shipped to Boston.

The profits derived from some of these mines are simply enormous. Thus, the Johnston-Irvine mine at Thetford, which some five years ago might have been bought for 5,000 dollars, now returns to its owners an annual profit of 100,000 dollars, producing as it does the finest quality of the mineral, a large proportion of which sells from 275 dollars to 300 dollars a ton, while the method of mining it is the crudest and most elementary imaginable. There is little or no excavation before the asbestos is reached, but the veins of the fibre are blasted out of the surface rock, and men with hammers separate the portions of rock that adhere to the pure asbestos, which is at once sorted into grades for shipment.

Some of the finest mines in Coleraine have been disposed of at a high figure to a firm of manufacturers of, and dealers in, asbestos goods at Frankfort. This firm is about to introduce improved machinery from Europe into these mines, not to increase the production, but to lessen its cost. There would be no difficulty at all in largely increasing the output of the mines, but the miners have a practical understanding among themselves to keep up the price of the raw product by allowing the demand to regulate the supply. Within the last few weeks there has been an attempt in Europe to reduce prices, manufacturers having quietly accumulated a certain amount of the mineral in excess of present requirements. The miners are equal to the emergency, however, and are storing the output of their mines here instead of shipping it on consignment.

THE CENTRES OF THE FRENCH SILK INDUSTRY.

The United States Consular Clerk at Lyons, in his last report, says that the geographical position of silk weaving in France has undergone considerable changes since the introduction of the industry. Cities, in which silk weaving was formerly of great importance, have turned their attention towards other industries; while new centres have sprung up, and attained more or less prosperity. In the 15th century, Rouen contained some silk looms, but the weaving of silk has long been discontinued there. The same may be said of Orleans. The silk manufacture established by the Popes at Avignon was, for a long time, in a flourishing condition; and its brocades, damasks, and brocatelles were sought for far and wide. In 1715, the height of prosperity was reached in this city, with 5,000 looms in operation, and a total production valued at £600,000. When the Popes lost control of Avignon, the city began to decline; its weavers emigrated, some to Nîmes, some to Lyons. At present, only a few looms are

to be found at Avignon, and these are generally engaged on plain cheap goods, for the account of Lyons houses. Tours was the first great silk-weaving centre of France. Under the direction of the Italian weavers, introduced by Louis XI., in 1470, a considerable degree of prosperity was soon attained. For the last 60 years the Tours silk industry has been declining, and at present employs but 1,000 looms, with an annual production of about £240,000. Nîmes was, likewise, one of the early centres of silk weaving. It was the home of a large number of Italian refugees, and suffered much less than the other silk centres from the expulsion of Protestant weavers. The 18th century was one of great prosperity for Nîmes, the number of looms reaching 3,000 for broad tissues, and 8,000 for silk-knitted goods. The number of looms at Nîmes and in the Gard Department is now estimated at 1,500. Ever since the 13th century there has been a small number of looms for silk weaving at Paris; but not until the present century did their output assume much importance. At present about 25,000 looms are employed in Paris and the adjoining districts in the weaving of silk and silk mixed goods, principally galloons, fringes, cords, and all other varieties of passementerie and trimmings. The total value of all these goods reaches about £2,800,000 annually. Nets, tulles, and laces constitute the specialty of Calais. This industry is of comparatively recent date, the first loom having been introduced by English smugglers in 1816. The real importance of Calais dates from the introduction of figured tulles in 1836. At present the number of looms at Calais and its suburb, Saint Pierre les Calais, is about 1,800. The annual production averages about £2,000,000, but is subject to great variations, owing to the fact that, whenever the demand for silk nets and laces is low, Calais manufacturers at once substitute cotton or wool on their looms to meet the demands of the trade. During the latter half of the present century Roubaix has become the centre of an extensive industry, manufacturing silk and wool, and silk and cotton mixed goods. These articles, though often wanting in originality, find ready sale on account of their low price. At Saint Chamond, silk weaving has been established in a modest way ever since the 13th century. During the 16th century, Bolognese refugees introduced silk throwing, which, together with ribbon weaving, attained considerable importance. The number of throwsters, owing to the revocation of Nantes, fell from 150 to 50, while weaving was entirely discontinued. This period of depression lasted until the beginning of the present century, when the introduction of braid weaving brought with it a general revival. By confining their attention to braids and similar articles, St. Chamond manufacturers advanced their specialties to a degree of excellence that has established for them a world-wide reputation. The present annual production is valued at £600,000, three-fourths of this amount being exported. At St. Etienne the weaving of

ribbons is less ancient than at St. Chamond, having been established about the beginning of the 17th century. The number of persons employed in the ribbon industry had attained 4,500 before the revocation of the edict at Nantes, but was reduced almost to nothing by this measure. The introduction in 1760 of the loom permitting the weaving of several pieces of ribbon at a time, instilled new life into the ribbon industry. By the end of the 18th century the number of looms had risen to 6,000, and in 1850 to 30,000. Since then a considerable rearrangement of the means of production has become necessary, partly on account of the introduction of power-loom, partly in order to keep down expenses, so as to meet the increased foreign competition. The value of the ribbon manufactured by St. Etienne is subject to great variations. In recent years the output has reached £4,000,000 sterling, of which about a third is exported. Formerly a much greater proportion was exported, but cheaper wages have enabled Basle and Barmen to undersell St. Etienne in plain and cheap ribbons. Lyons is considered to be the most important silk centre, not only of France, but of Europe as well. During the 14th and 15th centuries there were a few isolated looms in Lyons. In 1542 the total number of persons employed in the silk industry was 12,000. The 17th century was one of great prosperity for Lyons. Many important improvements were made in the processes of weaving, dyeing, and finishing, and many new articles were produced. At the time of the revocation of the edict of Nantes (1685), Lyons possessed 10,000 looms for broad goods, and 8,000 looms for ribbons and galloons. Within a few years all but 2,500 of these were driven out of the country. The 18th century became the most brilliant in the history of Lyons for the production of the richest kind of silk goods. The superiority in artistic taste and execution soon enabled the Lyonese to reconquer the markets of the world. The number of looms, which was 9,000 in 1750, had risen to 18,000 in 1789. Then came the revolution, and Lyons industries were, for the time being, completely ruined, and the 19th century was begun with but 3,000 looms. During the first decade of this century Jacquard's looms came into use. The cost of brocades was greatly diminished, they were brought within the reach of the middle classes, and their consumption was greatly increased. In 1850, the number of looms was 60,000. The total production was valued at £10,000,000, of which over £4,000,000 were figured tissues. Three-fourths of the whole amount were exported. During the last forty years the Lyons silk industry has witnessed many important changes. Among these may be cited the persistent efforts of the manufacturers to drive the looms out of the city into the country, to take them out of the control of the individual workman, and mass them in factories; the introduction and perfection of dyeing in the piece, and of new methods of printing and finishing; but most important of all, the introduction

and expansion of the power-loom. The number of hand-loom is now about 80,000, of which over 60,000 are scattered in the country districts. The number of power-loom, which was but 6,000 in 1873, is now nearly 25,000, almost all of which are in the country round Lyons, within a radius of 75 miles. The value of silk mixed power-loom goods has increased in the same proportion as the number of power-loom, and is now about £6,000,000 per annum. The total production of the Lyons silk industry averages about £16,000,000 per annum. The quantity of goods produced is now greater than ever before, and constitutes two-thirds of the production of France, and one-fourth of the total production of the world.

STEAM MACHINERY FOR EMBROIDERY MAKING IN SWITZERLAND.

The recent invention, at Arbon, of a new steam machine for making embroideries, threatens, says Consul Byers, of St. Gall, to revolutionise the most important manufacturing interests of the Swiss Republic. Eastern Switzerland, with St. Gall as a centre, has been for 100 years the head-quarters of the embroidery industry of the world. In the year 1890, cotton embroideries to the value of £3,600,000 were shipped from St. Gall to various quarters of the earth. The invention of a steam embroidery machine, that may more than triple the present enormous production of hand machines, and turn out embroidery of even a better quality than the present, is of sufficient importance to attract general attention. To the many thousands of Swiss people, who earn their livelihood by labouring at the hand machine, the invention is one of vital interest. The present hand machine for embroidery was brought into use in 1827. Embroidery by hand alone had long been practised, but it had only become an organised industry early in the present century, and was confined, as now, almost wholly to the mountainous part of eastern Switzerland—that is, the cantons of Appenzell, Thurgau, and St. Gall, with the town of St. Gall as the head-quarters for shipping. The technical skill and readiness of hand of the Appenzell women were marvellous, and gradually the embroidery made by them became famous all over the world. Very many thousands of the people are engaged wholly in the skilled business. Girls were trained to it from early childhood. At that time, all the work was done by hand, and in the people's homes, but the introduction of the hand machine rapidly changed the whole situation. At the present day, possibly not 5 per cent. of the embroideries are made exclusively by hand. The hand machine was soon in the houses of half the peasants, and factories were established, where many machines were set up and worked, but still by hand-power only. The character of the work was then, as now, very good, but the production was comparatively

slow. This common old embroidering hand machine of 1827, with few improvements, is the one that is used to day for the millions of fine embroideries that are sold to all quarters of the globe. There are about 23,000 of them in use in eastern Switzerland, the number of needles averaging about 250 to the machine, and the number of stitches not exceeding 2,000 to the needle daily. As embroiderers are paid on the stitch basis only, and sometimes as low as two-pence farthing a hundred, they have very small earnings left after paying all expenses. At the present time two shillings, sometimes less, is a fair average of the daily earnings of a hard-working embroiderer, who must toil a long day with head, hands, and feet. To produce a machine that would increase the number of stitches, and with less labour, has been the aim of inventors for nearly fifty years. Some fifteen years ago a machine called the "Schiffli" was invented and worked by steam. It produces, however, only a low class of goods of inferior quality. The product of this machine is usually known as "Schiffli goods" or Schiffli embroideries. A little later, other and greatly improved steam machines for fine embroidering were invented, but failed to enter into general use. For seventeen years a firm at Arbon, on Lake Constance, have been striving to solve the problem of a rapid, perfect acting steam embroidery machine, that will increase the production, lessen the labour, and even improve the quality of the goods. This firm believe they have accomplished the desired object in their new "Arbon" machine. The principle upon which the invention proceeds appears, says the United States Consul, to warrant belief in its great success. It is a power machine, but retains some of the ideas of the old hand machine. The short thread is still used, but with a vertical tension, by spring motion, in place of the horizontal moving carriage of the common machine. The needles are all put in place at once by means of a bar that is replaced as often as needed, saving valuable time. The pantograph that moves the frame holding the cloth is moved by steam, and follows the pattern by means of an automatic attachment which takes the place of the trained embroiderer. What is claimed for this invention by its owners is that it will at least triple the product of the hand machine, that it can produce goods cheaper, and that it can turn out goods quite as good if not better than by the old method, and do it without so much of the wear and tear to the muscles of men and women. It has different improved attachments, such as "Bohrers," steam needle threaders, automatic pantograph, &c., that aid in the rapid production. The hand machine seldom produces much above 2,000 stitches daily on an average. The Arbon machines, when placed two together, with the single automatic pantograph acting for both, will, it is claimed, produce 12,000 to 15,000 stitches daily. It requires no rest and can be worked twenty-four instead of twelve hours. Two hand machines, worked by two men and two girls, may, it is claimed, be forced to produce 5,500

stitches daily, but even then, if the estimates are all correct, the Arbon machine would nearly triple the production, allowing nothing for the advantages of power over hand machines in many other directions. A drawback to the Arbon machine is the expense of its manufacture—£200 to £280—as compared with £80 and less for the best pattern hand machines. Its great production, too, would indicate that it is suitable only for articles that are demanded in immense quantities. It is maintained, however, that this is not an objection, as the machine will produce almost everything in the embroidery line.

Correspondence.

THE SULTAN'S "TUGHRA."

I have followed the valuable communications of both Sir George Birdwood and Mr. Hyde Clarke on the tughra with great interest; and I should like to add a few notes upon it. It was as far back as 1869, when I chanced to be in Constantinople, that I made inquiries about the origin of the "Sultan's Cypher." After so many years, I fear that now I can only give the general purport of what was told me at that time. I was thrown into the company of some Effendis, who spoke English; and they were something like Sir George's friends, to whom he refers in his last communication; when I asked about the origin of the tughra, all they could tell me was, that it was "only a flourish"—"a mere ornament." I persisted that there was likely to be something more in the Cypher than they said; and at last I found some one—I quite forget now who he was—who told me that the Sultan's tughra had been originally a hand. Since then, I found another person, who confirmed the hand origin; but I quite forget who told me about the use of the blood with the hand in signing important State documents. I quite feel how uncertain all this is, and I have often wished for more authentic information. Perhaps Sir George Birdwood, or Mr. Hyde Clarke—who, I know, is full of knowledge about Turkey—may be able to give us some light on the matter. Sir George is probably right about the use of the blood not being according to Mohammedan ideas; but the likelihood is that the custom was brought from their original home by the Turks in Central Asia. I find some support for this in Malcolm's "History of Persia." In describing the conquests of Timour, he says:—"The officers of the conqueror's army were appointed to the charge of the different provinces and cities which had been subdued; and on their commissions, instead of a seal, an impression of a red hand was stamped: a Tartar usage, that marked the manner in which the territories had been taken, as well as that in which it was intended they should be governed" (chap. xiii). I understand that if the

Sultan issued similar documents at the present day, they would have the tughra upon them, instead of the "Red Hand." From this it appears that the one is at least the successor of the other. If the "Red Hand" is as old as Timour's period, it may be rather hard to trace its origin. In the Kazan Cathedral, St. Petersburg, which contains numerous trophies taken by the Russian troops in battle, I have seen a Turkish standard, which is surmounted by a hand with the fingers spread out. This would go far to prove at least that the hand has been, in Turkey, a symbol of power and dominion. In India I have seen a gold hand, on the end of a pole, carried with other *nishans* in the *sowarie* of a Raja; this would tend to prove that the hand as a symbol of authority is old, as well as wide-spread, in the East. That the hand was used among the Mohammedans as a seal or sign manual, may be supported by the curious legend which the Turks relate about the erection of St. Sophia in Constantinople. They say that in building the dome it repeatedly fell, but at last a pious monk went to the prophet at Mecca, from which place he brought seventy camels laden with water from the Zem-zem well, seventy camels with earth from the Holy City, and some of the prophet's saliva in a little box. From these materials mortar was made with which the dome was again reconstructed; and it has stood firm and secure ever since. The historical accuracy of this tale need not be discussed. The point of it is in the following. When the precious load was about to leave Mecca, Abou Taleb prevailed on Mohammed to give his sign manual as a protection to the caravan in travelling to Constantinople; this he is said to have done by dipping his hand into black ink, and stamping it on a gazelle's skin. This helps to confirm, so far, what Sir George Birdwood says, that the use of blood is not Mohammedan, but at the same time it is evidence that the practice of using the hand as a seal has not been at all times foreign to the ideas of the people of Constantinople. I am assuming here that however absurd a legend may be, yet the local manners and customs described in it may be true enough. Mohammed had, if I mistake not, among his titles that of "The Hand of God;" the Jews place a hand, often elaborately sculptured, on their houses for good luck; this is, according to Major Conder, known as the "Hand of Might," and he quotes Dr. Chaplin as his authority that Jewish wedding rings in Jerusalem are in the form of a hand. (See "Quarterly Statement of the Palestine Exploration Fund," for July, 1882, p. 146.) Here we have the hand taking the place of a seal on a ring, as well as possessing the talismanic attribute which Sir George Birdwood says is ascribed to seals in the East. Almost everywhere in the East a hand, or the mark of one, is looked upon as a charm, particularly against the evil eye. With the Shias of Persia the hand of Ali, called "Panjeh," from the five fingers being spread out, is a most sacred symbol. When in Persia I procured a small

cake, octagonal in form, made of the earth of Kerbella; in the centre is the hand of Ali, the "Panjeh," with the fingers spread out. The Shias use these at their devotions, placing them as a Kiblah before them; and in the prayers, when a Mohammedan would touch the ground with his forehead, the Shia touches this cake of holy earth. What is here given will serve to show how important as a symbol the hand has been; but, unfortunately, it is not direct evidence regarding the origin of the tughra. Perhaps it may be the means of eliciting information from some one who has knowledge on the subject.

WILLIAM SIMPSON.

General Notes.

FORESTRY IN AUSTRIA.—The United States Consul-General at Vienna says that, according to the latest statistics, the total area of the productive land of the Austrian Empire is 28,406,530 hectares (hectare = 2.47 acres). Of these, 9,227,061 hectares are forest lands, of which 1,381,433 are hard woods, 6,587,853 pine woods, and 1,257,775 hectares brushwood. The forests cover about the fourth part of the empire, and are of great value. Their cultivation and preservation, and the administration of the laws with reference thereto, are entrusted to the Ministry of Agriculture, the provincial presidents, and district officers. Their subordinates must all pass an examination, and are divided into permanent and voluntary officers. The former are promoted like military officers; the latter enter the service for the purpose of pursuing their studies practically, but receive a moderate salary. They are classified as counsellors, commissaries, and inspectors. A forest register is kept, and maps are drawn of each district, which specify the number of acres covered by forest, its condition, age, and state of growth. The total number of forest officers of all grades, public and private, employed in Austria, reaches the figure of 31,826. The expenditure for Government forests amounts to 3,546,240 florins, and revenue to 3,951,650 florins, showing a profit of 405,410 florins. The Government forests contain 952,690 hectares, municipal 1,297,238 hectares, and private forests 6,977,133 hectares. The largest private owners are the Emperor, 35,000 hectares; Imperial family, 25,000; Archduke Albrecht, 115,000; Prince Johann Lechtenstein, 136,103; Prince J. A. Schwarzenberg, 110,718; Count Schonborn, 124,563; Prince of Saxe Coburg, 74,181; Baron von Sina, 60,000; and Prince Esterhazy, 85,000 hectares. The forest schools of Austria are divided into elementary schools, middle schools, and high schools or universities, and, says Consul-General Goldschmidt, are doing splendid work to fit and educate young men for their future duties, and are worthy of imitation by many countries.

Journal of the Society of Arts.

No. 2,029. VOL. XXXIX.

FRIDAY, OCTOBER 9, 1891.

*All communications for the Society should be addressed to
the Secretary, John-street, Adelphi, London, W.C.*

NOTICES.

FOTHERGILL PRIZE.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire.

A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres or other places of public amusement.

In cases where the Invention is in actual use, reference should be made to places where it could be inspected.

A full description of the Invention, accompanied by such drawings or models as are necessary for its elucidation, must be sent in on or before the 31st December, 1891, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding the Prize, in case there is nothing in their opinion deserving the award, or sufficiently complying with the conditions sent in for competition.

Chicago Exhibition, 1893.

Forms of application for space, and prospectuses with detailed information, will be issued shortly, but, in the meantime, intending exhibitors can apply to the Secretary of the Royal Commission, Society of Arts, John-street, Adelphi, and their names will be noted at once, with a view to their receiving early copies of the prospectus when ready.

Proceedings of the Society.

CANTOR LECTURES.

THE DECORATIVE TREATMENT OF
NATURAL FOLIAGE.

BY HUGH STANNUS.

(Lecturer on Applied Art at University College.)

[THE RIGHT OF REPRODUCING THESE LECTURES IS RESERVED.]

*Lecture I.—Introduction.—Delivered 13th
April, 1891.*

§ 1.—THE ELEMENTS OF DECORATION.

The chief impelling Motives which have caused that treatment of objects which is now termed *Decorative*, have been :—

- (a) That necessitated by the Usage, which is FUNCTIONAL ;
- (b) That resulting from the Instinct to please the eye, which is ÆSTHETIC ;
- (c) That arising from the Desire to record or to teach, which is the DIDACTIC motive.

The ÆSTHETIC instinct of the early peoples was gratified by :—

- (a) The *forms* of their weapons or tools ;
- (b) The *patterns* with which they are decorated ;
- (c) The *imitation* of the surrounding animals, *e.g.* the Deer scratched on the horn at the British Museum.

Imitation was afterwards applied to the vegetable creation ; and much of what is termed Ornament was derived from that class of elements.

The ELEMENTS OF DECORATION are the material used by the Artist. They might be considered to include everything that is visible ; but since Decoration is a result of the æsthetic instinct : the field is narrowed to such as are pleasing *at the first glance*. And the selection is further limited to such as are suitable to the shape and size of objects.

They may be classified according to their relative Dignity, as follows :—

- The Human form,
- Animal forms,
- Natural foliage,
- Artificial objects,
- Artificial foliage, and
- Geometrical figures.

§ 2.—THE TWO KINDS OF FOLIAGE.

A DISTINCTION is made between natural and artificial foliage. They have much in

common; and consequently many have supposed that our Western artificial foliage is merely a very-much-conventionalised version of natural foliage. The supposition is correct with regard to Eastern Pattern-work, but not in Western Architectural ornamentation.

A simple generalisation may make this clear. The ordinary stock foliage of the Ornamentist was evolved in connection with:—

(In the West)	(In the East)
ARCHITECTURE, as in Greece.	TEXTILES, as in Persia.

Hence the primary Elements of decoration were derived from:—

(In the West)	(In the East)
GEOMETRICAL LINES, <i>e.g.</i> the meander, spiral, &c.	NATURAL FLOWERS and LEAVES, <i>e.g.</i> the pine, pome- granate, &c.

Further, it may be observed that the Method of treating these Elements has been different:—

(In the West)

The Geometrical lines were enriched by the introduction of the details of Natural vegetation; thus becoming gradually more *natural-
esque*.

(In the East)

The Natural foliage was codified by the introduction of Geometrical arrangement; thus becoming gradually more *artificial*.

AN APPROXIMATION between the two treatments, sometimes appears; but the two kinds—Artificial, and Natural—are essentially different in origin; and should be kept distinct in their application.

This Approximation may be shewn, in a tabular arrangement, thus:—

GEOMETRY NATURE

The patterns are merely straight-lines, dots, and portions of circles.

The plants are copied as accurately as possible.

The lines become stems.

The plant is applied without repetition.

Leaves are added to the stems.

Repetition is used with the plants.

Serration is added to the leaf-edge.

Weaving-economy induces Symmetry.

Similarity of serrated leaf-edge to the Acanthos plant, is observed; Imitation becomes more direct; and this artificial foliage becomes termed "Acanthus".

Symmetry induces Geometrical Severity, and the Omission of all details of the original plant which are not easily worked in connection with geometrical arrangement.

Flowers, generally circular in mass-shape, are added at the ends of the spiral stems.

The Flowers and Leaves (*only*) survive; the growth of the stems is forgotten; and Tradition does the rest.

§ 3.—APPLICATION OF THE TWO KINDS.

Each of these two kinds of foliage has its own proper use. Artificial foliage is appropriate to the enrichment of Architecture; and Natural foliage to those objects which are not architectural, but are termed "moveables", including under this term, Furniture, and more especially Hangings and other applications of the Textile art.

This may be seen on comparing the two columns below, of which the L.H. one refers to Architecture, and the R.H. one to Natural foliage:—

(Architecture)

(Natural foliage)

RULES:

Governed by severe rules of Repetition, Axiality, Symmetry, &c., which are apparent to the passer-by. Hence Artificial foliage, being regular in its structure, is more appropriate than the (apparently) irregular growth of Natural foliage.

Exhibits *apparent* playful Freedom. There *are* underlying Rules, which are detected by the scientific Botanist; but these are not seen by the casual observer.

(Architecture)

(Natural foliage)

CHARACTERISTICS :

Rigidity and Stability.

Elasticity and Tremulousness in every breeze.

LINES OF COMPOSITION :

Geometrical lines. The geometrical lines and spirals of Artificial foliage demand an un-moving surface for proper view.

They would generally be spoiled if not on a plane surface.

Indeterminate curves, which are very subtle, and varied, and therefore suitable to a hanging and swaying material.

The curves of Nature are not spoiled when on a folded material.

DISTRIBUTION :

Symmetrical. The symmetry of artificial foliage is appropriate to that of Architecture.

Balanced. The growth of natural foliage is generally symmetrical; but this is not apparent.

BEAUTY :

Depends on *form*, with colour as a secondary adjunct.

More appropriate to objects which depend on *colour* for their principal charm.

There have been waves of the desire to introduce Natural foliage into Architecture (*e.g.* in the "Decorated period" of Gothic architecture); but the Artificial elements have always proved too strong, and the two have never mixed. In Architecture, everything has three dimensions; and the artificial foliage is carved with leaves, &c., of a suitable thickness: in Natural foliage the tenuity of leaves, &c., is such that it cannot be reproduced. Even in the architraves round the glorious Doors at Florence the natural foliage is not always a success; and where Ghiberti has stopped-short in the ductile bronze, it is not probable that the modern carver will succeed in stone. It may therefore be suggested that the close imitation of Natural foliage should be confined to objects of *two* dimensions, *i.e.* to plane surfaces and figured materials.

This selection of the Elements of Decora-

tion, according to their association—is analogous to the selection made use of by the Poet, from the words and ideas, which are his Materials. It will be observed that as—on a Classic or Heroic subject, the choice is of learned words and classical ideas; and on a Domestic or Pastoral one, simple words and homely similes are used—so, in conjunction with the severe forms of Architecture, the formal character of artificial foliage is suitable; and for decorating Textiles and other moveable Accessories, the Natural foliage, with which the earth is clothed and beautified, is appropriate.

ENRICHMENT-OF-SURFACE may be beautiful for one reason: IMITATION-OF-NATURE is beautiful for another. When imitations of natural foliage are introduced decoratively on a surface: then may it be twice beautiful—firstly in the *principles* according to which the distribution is arranged; and secondly because of the *elements* which are worked-in being beautiful in themselves. Geometrical elements might be so used as to serve the first end; but can never fulfil the second: Storiatio fulfils the second; but its increase of interest absorbs the first.

THIS COURSE of Lectures is intended to treat of Natural foliage; leaving Artificial foliage to be dealt-with at another opportunity. It is not Historical. The History of the Decorative treatment of Natural foliage, shewing its evolution in the past, is a large and interesting theme; but, unless this were accompanied by critical remarks based on given principles, the method might be barren of results. Tradition is not to be undervalued; but the student should be led to Tradition through Principles.

It is further intended more especially to apply to the æsthetic use. When natural foliage is used Æsthetically (*i.e.* decoratively): then the Shape of the surface should govern the Mass-shape of the foliage; and there should be Parallelism between them (see § 29). When used Didactically (*i.e.* symbolically:) then the foliage may be treated more freely.

§ 4.—THE FOUR TREATMENTS.

There are, broadly speaking, four methods of treating Natural foliage. These may be arranged, in a Chart, according to their relation to the two poles of Art and Science; from Realism (which is all Art and no Science) to the "Botanical Analysis" method (in which is a little Science but no Art), thus:—

ART POLE.....SCIENCE POLE

Realism
(See § 10).

Conventionalism
(See § 14).

Disguised Artificialism
(See § 6).

Botanical Analysis
(See § 5).

The first two of these methods are Artistic and legitimate: the others are inartistic and misleading. Before treating of the artistic methods it will be well to clear the ground by dismissing the others.

§ 5.—THE BOTANICAL ANALYSIS TREATMENT.

In this method the student was taught (i) to draw each plant with the Stem *straightened-out*, the Leaves *flattened-out*, and the Flowers represented as in *side-elevation* or *plan*. (ii) The Flowers were further *pulled-in-pieces*, and the Petals were *flattened-out* in a manner similar to the Entomologists' practice of displaying their "speci-

diagrams can be looked-upon as Pictures. Some knowledge of external Botany is useful to a Pattern-artist as some knowledge of external Anatomy is useful to the Pictorial-artist. In each of these cases, the Science, which discovers and records facts, is subservient to its sister, Art, which uses the facts to interpret appearances; and—when scientific diagrams are put forth as Art—the Science is in its wrong place: it has then been treated as if it were the Building instead of being only the Scaffolding; and the results of such attempts cannot be considered as complete or final.

Examples of this method are given in figs. 1 and 2. It was officially encouraged about



FIG. 1.

mens" scientifically. Often, also, (iii) the Stems and Buds were *cut-through*; and "patterns" were made with the Sections.

With regard to the first of these practices (i): it should be observed that much of the beauty of appearance of natural foliage results from the variety of view, the subtle curvature, and the foreshortening, as seen in perspective; and that to sacrifice all these for the sake of a *diagram* would be a wasted opportunity.

With regard to the other practices (ii) and (iii): it is obvious that these statements of the facts of the plant are useful as a part of the Science of Botany; but can no more be considered as making Decoration than Anatomical



FIG. 2.

25 years ago; and books like "Plants their Natural Growth and Ornamental Treatment", and "Suggestions in Floral Design", both by F. Edward Hulme, F.L.S., &c., shew it at its best.

In criticising this method, there is no desire to cast any slight upon those who were responsible for it. They were groping in the dark; and did the best they knew, according to their lights. But—Japanese work was not known at that time—and, but for that, the Pattern-artist of to-day might still be occupied in pinning leaves and flowers against the wall. It was moreover a protest against the Cabbage Rose on the Hearth-rug, that some may still remember with shuddering.

§ 6.—THE DISGUISED ARTIFICIALITY TREATMENT.

In this method the student was taught to sketch-out what he considered to be good Curves and Spirals; and then (i) to bend the selected plant so that its stem might coincide with them, regardless of its own proper natural growth; or (ii) to deck-out the first-drawn spirals with the leaves and flowers of the selected plant.



FIG. 3.

With regard to the first of these practices: it is much more foolish than the Analysis method; and is little short of blasphemy against the Great Designer. He has determined how each plant shall grow: how, within limits of cultivation, its stems and branches shall separate, each to seek its own share of air and sunshine; how its leaves shall stand erect or droop, each according to its function; and always in perfect beauty. And further: how each family of plants shall have its own method-of-branching; which is as much a

part of its character and often of its beauty as are the Flowers and Leaves.

The second practice, which generally produces a result similar to the first, is quite as unthinking. It is more often practised; and is responsible for many of the laboured and uninteresting designs which are common. If the Pattern-artist deck-out the old worn-out and commonplace spirals with leaves and flowers borrowed from Nature—the result is like the “voice of Jacob and the hands of Esau”: it is merely a Disguise of Artificiality.

An example of this method is given in fig. 3. It was generally practised in Germany; and books like “Das Vegetabile Ornamente”, by K. Krumbholz, shew it at its best.

If this treatment were universally followed—there would soon be an end to design with natural foliage. The spectator might observe one border which appeared to be a Rose, another a Tulip, the third a Thistle, and the fourth a Fuchsia; and, on examination, discover that these were not Rose, Tulip, Thistle, and Fuchsia; but merely that very artificial old friend—the Spiral-scroll—in disguise.

An apologist for this method remarks:—“***** In such matters as the ramification of plants, * * * nature is always making angles and elbows [*sic*] which we are obliged, in decorative treatment, to change into curves for our purpose; *****”. This opinion needs only to be applied to animals in order to exhibit its absurdity; and with regard to plants, it will be seen that this tampering has not even the poor merit of success.

§ 7.—NOTE ON SYMMETRY.

A desire for Symmetry often accompanies these two treatments. This is a quality to be avoided whenever possible in Natural foliage design. The so-called “Turn-over patterns” are an economy in Weaving-design, but the economy is of the wrong kind. An artist should spend his thought to spare material or cost in working. When he spares his *thought*—making the least amount of thought cover the greatest amount of surface—then is his work worth to the world just what it has cost him, *i.e.* very little.

So injurious is the influence of Symmetry in Natural foliage design, that it might almost be a test question—“Is the design symmetrical?”. When the exigencies of Machine-reproduction necessitate this with Natural foliage—it is a hardship which the Artist regretfully accepts, and no one would willingly



FIG. 4.



FIG. 5.

make a design for Hand-reproduction which was symmetrical: rather would he spend himself to ensure the worthier result which ensues from Balance.

An example of Symmetry is given in fig. 4; and of Balance in fig. 5. Each panel contains two classes of Elements:—Natural foliage (*i.e.* two branches of the Bay tree), and an Artificial object (*i.e.* a Ribbon which ties them). The lower Element (*i.e.* the Ribbon) is treated symmetrically in both panels: the higher Element (*i.e.* the Branches) are *symmetrical* in the former panel, and *balanced* in the latter. This latter treatment will be seen to be not only the more interesting, but the more like the infinite variety of Nature; while the former is a wasted opportunity, and contrary to Nature.

The Student will observe by experience that the mind soon tires of Artificiality, both in Curvature and in Symmetry: the lines of Nature have a pleasant freshness and inexhaustible variety; and the *Natural* method of treating Nature is not only the most true, but also the most beautiful.

§ 8.—REALISM AND CONVENTIONALISM: DEFINITIONS.

REALISM—the result of *Realistic* treatment, *i.e.* the attempt to render the reproduction as like the reality as is possible, even to the verge of deception—is the aim of the Pictorial - Artist. In Pictures the surface appears to have been annihilated, and the spectator beholds the scene as if there were a hole through the wall. It is not the highest, and should not be the only aim in Art; but it has always been sought-for and admired. It requires perfect conditions, of materials and tools; *i.e.* *complete Technical appliances*.

CONVENTIONALISM—the result of *incomplete Technical appliances*, and the attempt to render so much of the Beauty of the original as is possible, with due regard to their capabilities—is the aim of the Decorative-Artist. It is not the highest aim; though a necessary curb in Decorative-Art, both for the technical reason, and also as a result of the Position or Function of the object.

It will thus be seen that the two words, when used with regard to foliage of any kind, refer to the *Method of representing it*, and not to its Kind or its manner of Growth.

§ 9.—SCALES FROM REALISM TO CONVENTIONALISM.

These two methods, when applied absolutely, form the two extremes:—The most complete REALISM being at one end, and the most limited CONVENTIONALISM at the other. There are scales of gradual reduction between them, which may be shewn on two charts:—

(i) Reduction in the NUMBER OF PARTS which preserve their Realistic rendering;

(ii) Reduction in the DEGREE of REALISM through all parts.

(i) According to the Number of the features or parts of the design which are treated with less than realism. Thus there might be a panel representing a Window-opening with an architectural framing, with a Flower-vase on the cill, and a Landscape-background. The first part to be reduced in realistic rendering would be the Background, and the second would be the Framing, leaving the third part, the Flower-vase, as the survival. This is a Scale of reduction in *Number of Parts*.

It may be shewn, in tabular arrangement, thus:—

REALISM		CONVENTIONALISM.	
COMPLETE OR PICTORIAL REALISM, in which all parts are realistically represented (see § 10).	SEMI-PICTORIAL REALISM, in which the Back-ground is reduced to a flat-tint, while all the remaining parts are realistically represented (see § 11).	DECORATIVE REALISM, in which the chief Feature (<i>only</i>) is realistically represented, and all the other parts are reduced to conventional renderings (see § 12).	COMPLETE CONVENTIONALISM, in which all parts are reduced to conventional renderings (see Conventionalism).

Inasmuch as there is some realistic part remaining in each of the first three methods—these are classified under the heading of REALISM.

(ii) According to the Degree in which colour, gradation, or shading, is sacrificed, in consequence of the limited Means at the disposal of the Artist; resulting in the gradual

departure from Realism to the most severe Conventionalism. The reduction is applied to all parts of the work. This is a scale of reduction in *Degree*. There are two Varieties in each

degree; and they are marked with italic letters.

It may be shewn, in tabular arrangement, thus:—

REALISM CONVENTIONALISM

COMPLETE REALISM, in which all parts are represented, in proper colours, and perfect gradation, with correct light-and-shade (see § 10).	FIRST DEGREE OF CONVENTIONALISM, in which all parts are represented: (a) By a reduced number of Pigments, the other qualities remaining; (b) By reduction in gradation and shading to Flat-tints of several pigments (see § 15).	SECOND DEGREE OF CONVENTIONALISM, in which all parts are represented: (c) By a reduction to Monochrome of colour, with Gradation (<i>only</i>) remaining; (d) By reduction to Monochrome of White and Black, with Gradation (<i>only</i>) remaining (see § 16).	THIRD DEGREE OF CONVENTIONALISM, in which all parts are represented: (e) By reduction to a Flat-tint of one pigment on a ground of another; (f) By reduction to a Flat-tint of White on Black, or <i>vice versa</i> (see § 17).	ULTIMATE CONVENTIONALISM, in which all parts are represented: (g) By reduction to Outline of several pigments; (h) Reduction to Outline of one pigment (see § 18).
--	--	---	---	--

Inasmuch as Realism ceases so soon as any reduction in the three qualities (of colour, gradation, and shadow) is introduced; and the treatment becomes more Conventional in each method after the first—these are classified under the heading of CONVENTIONALISM.

[There is an analogous scale of reduction in Form, from the Complete-relief of an isolated Statue to the Flatness of a Floor-plate; but this does not belong to the present subject.]

Miscellaneous.

PINE-APPLE CULTIVATION IN THE UNITED STATES.

In a report recently issued by the United States Secretary of Agriculture, it is stated that it may not be generally known that pine-apples are grown successfully in field culture in that country. The industry is, however, limited to Southern Florida, for not only does a slight frost seriously damage the plant, but chilly air, either day or night, is injurious, and dry air at any temperature is not suitable. Many persons think that any situation where frost does not come will suit the pine-apple and other tropical plants and trees, but this is far from being the case. In the extreme southern part of Texas and in many places in California it would succeed if the nights were as hot as the days and the air moist. A few partially successful attempts have been made in California. Even the central part of Florida does not seem so well suited to pine-apple culture as the coast regions from Merritt's Island southward to Key West, and northward from there to Tampa Bay, in which region there are hundreds of acres yielding this fruit abundantly. The islands seem especially favourable, as their foundation is usually coral rock,

upon which is a well drained sandy soil mixed with decayed vegetable matter. Although thin sandy soil may produce light crops, rich soil is much better. Key Largo, Plantation Key, and Pine Island are some of the most profitable places for pine-apple culture in all Florida. At Biscayne Bay, on the east coast, are very many fine plantations, and also on the shores of Lake Worth, which lies opposite the south end of Lake Okechobee. Northward of this place lies the narrow sound, which is known as Indian River, and for over a hundred miles along its shores may be found patches of this fruit at the home of almost every settler. At Eden, which is on the mainland side, are some of the largest plantations in Florida. It is estimated that fully half a million fruits of marketable size were shipped from this place in 1890. On Merritt's Island are also many commercial plantations, and it may be stated that this is the northern limit of the pine-apple cultivation. It is true that all over the orange-growing region of Florida the pine-apple is occasionally grown under temporary protection, but not otherwise, except in a few favoured situations. Near Orlando there are some fields which are reported as yielding a large and paying crop this year. The plants thrive best which are set from three to four feet apart each way, although some growers set them closer. The hoe is the principal tool used in cultivating, but horse cultivators are used with advantage until the plants get too large. The edges

of the leaves of nearly all varieties are armed with sharp teeth. A plantation will last about three years without renewal, and bear good crops. The first year the young plants bear little or no fruit, but the second year each should have at least one good large one, and the third year two or more, but there is usually a considerable proportion of small ones, which are unmarketable, of less than about four inches in diameter. Propagation is always conducted by offshoots, which are of three kinds, and known by the names "crowns," "sets" or "slips," and "suckers." The crown is that part which appears at the top of the fruit, and consists of a single bud in the centre of a cluster of leaves. Very small shoots, called "crownlets," are sometimes found at their base. The slips or sets are found about the base of the fruit, and, although small, are numerous, and usually used for propagation. The suckers are branches which come out of the main stalk near the ground, and come into bearing soonest of all. All the above take root very easily. There are many named varieties, which differ in style of plant, and the fruit varies in size, shape, colour, flavour, and time of ripening. Specimens have been exhibited weighing nearly ten pounds, and even larger pines than these have been grown. New varieties are produced from seeds as are other new fruits. The "Queen" is one of the varieties about which there is considerable confusion as to name. In Florida it is called "Egyptian Queen," and also "Gypsy." It is one of the best flavoured varieties, and is of a beautiful lemon-yellow colour. No variety fetches a higher price in the market, according to the experience of Florida growers. In shape it is rather elongated and is only medium sized. The "Porto Rico" pine is grown to some extent, but does not multiply rapidly. The plant is very large, and the leaves often attain a length of five feet. The fruit grows to the largest size, and specimens weighing ten pounds are not rare—some even reach twenty pounds in weight. The colour, when fully ripe, is a pale pinkish yellow. The protuberances are very large, and the flavour is sub-acid. The "Red Spanish" is the variety which is generally grown in Florida. It is not large, and rarely weighs more than five pounds. The shape is almost globular, and the colour a brownish yellow, at maturity. The flavour is sub-acid, vinous, and very delicious when fully ripe.

Correspondence.

THE "TUGHRA" OF THE SULTANS OF TURKEY.

In writing of the *tughra* of the Sultans of Turkey, I have hitherto confined myself, as much as possible, to the description, and history of the origin, of this

specific sign-manual; and have carefully refrained myself from extending my remarks to sign-manuals in general, and the endless subject of the symbolism of the hand. But Mr. William Simpson's letter, at pp. 857-8 of the *Journal*, necessitates my adding a few observations under both these heads, by way of supplementary illustration of the facts communicated by Mr. Hyde Clarke and me regarding the renowned *tughra* of the Turks.

From my first letter it will have been understood that *tughrai*, literally "flourished," writing is not peculiar to the Turks. It is in universal favour throughout Islam—that is, the countries of the Old World under the influence of Arabic, or rather "Saracenic," culture. The Mo(n)gol Emperors of Delhi not only had their *farmans* ["commands," "patents"] superscribed with a distinctive *tughra*, but sometimes had them engrossed throughout in the *tughrai* style of Oriental caligraphy; and they imprinted the signet seal ["secretum"] personal to themselves above the dynastic *tughra*. These *farmans* and their *parwanas* ["warrants," "licenses"] and *barats* ["drafts"] were folded up, from the bottom upwards, into seven folds, and imprinted with the signet seals of the various attesting officials, in the order of their rank, from the lowest fold, to the third, fourth, or fifth, the emperor's seal, which was applied only to the *tughrai farmans*, surmounting the whole, at the top of the seventh fold. Among Orientals, private letters, if to an inferior, always have the signet seal imprinted at the top; if to an equal at the side; and to a superior at the bottom. It is a nice point between equals how far up or down the side of a letter they should impress their seals; and the quality—that is, the decoration—of the paper used has also to be regulated by the official rank, or social position, of the person addressed. But all this antique etiquette is fast perishing out of remembrance under the pressure of the cheap importation of European pens and ink and paper, and foully bacilliferous adhesive envelopes.

Mr. William Simpson is quite right in his presumption that the Tartars used the actual imprint of their hands as a sign manual long before the elaboration of the special *tughra* of the Turks, and that it was red. But it was red not from any association with bloody rites, or legends, but from the more or less direct connection of this manual mode of signature with the world-wide symbolism of the right, that is the male or red hand, as distinguished from the left, that is the female or blue hand. Universally (except in China) the giving of the right hand has been regarded as an inviolable pledge of surety [cf: Proverbs, xvii. 18 and xxii. 26]; and where the actual hand could not be given, the parties to any contract, social, commercial, or political, soon learned to apply to the leather, cloth, leaf, paper, or parchment embodying it, the imprint of their hands. The passage from hand-shaking to hand-signing is most pertinently indicated by the 21st verse of the 11th chapter of

"Proverbs," the original Hebrew of which may be equally correctly translated:—"[Though] hand [join] in hand, the evil man shall not go unpunished," or—"My hand [imprinted] upon it! the evil man shall not go unpunished." Mr. William Simpson's anecdote of the prophet Mahomed dipping his hand into black ink, and stamping it on a gazelle skin, was first told by the interesting Cornishman, John Carne, who travelled much in Anterior Asia at the beginning of the present century, and printed the results of his observations in the *New Monthly Magazine*, subsequently republishing them in a now rare volume of "Letters from the East." But Mahomed never used black ink for his sign manual, but red pigment. Nor was Mahomed ever entitled "The Hand of God." It was his cousin and son-in-law, Ali, who was entitled "The Hand of the Lion [*haidar*] of God." "The famous Hyder Ali" frequently used, instead of his signet seal, the imprint of his hand, or, as it is termed in India, the *panja* or "five" digits; and he did so not in conformity with traditional custom, but simply because he was named "Hyder Ali," after Ali, the "Exalted" one, the *haidar-i-alah*, "the Lion of God," whose standard is the extended right hand, called in India the *panja-i-haidar*. It is generally of gilded copper gold, being associated with red throughout the East. But "Hyder Ali," notwithstanding that the colour red is forbidden to all true Mahomedans, used a red mixture of sandal wood, safflower, and gum for his sign manual. The sacred standard of the sultans of Turkey, traditionally said to have belonged to the prophet Mahomed, is a banner of green silk surmounted by a hand; but it is not the hand of Ali. Both these symbolical hands appear much earlier in history than the sultans of Turkey and Ali, and go back, indeed, far beyond human history. The outstretched right hand was the standard of the Roman manipulus, or "company" [literally "handful"] of sixty soldiers; whose original standard was a "handful" of straw, or dried fern leaves tied to the top of a pole. Like the Roman dragon standard, it was obviously derived from the East, and probably directly from the Carthaginians, on whose monuments it frequently appears, both as a male and a female emblem. Later it appeared on the sceptres of the Byzantine Cæsars, being assumed to symbolise Justice; and, still later, we find it as the "dextera Dei," representing the first person of the Trinity in Christian Art. Always the utmost sanctity has been attached to the hand as a symbol, and that in parts of the world not known to have been in communication with the Old World before modern times. Thus the ancient Mexicans worshipped the *Cheirostemon platanoides*, because its stemns resembled the human hand. Apuleius ["Golden Ass," p. 230 of Bohn's translation] tells us that, among the symbols borne in the procession of the "great mother," Isis, was a golden extended "left hand," "the symbol of Equity." In Egypt, representations of "the hand

of Isis" in blue glass were worn in necklaces, along with representations, in blue, white, and black glass, of "the eye of Osiris." I possess examples of these identical symbols, presented to me by Mr. C. Purdon Clarke, C.I.E., as manufactured in the present day at Hebron, in Palestine, under the names of the "Eye of God" ["occulus Dei"], and "the Hand of Mary" [*kaf-i-miriam*]. Similarly, the root of the *Cyclamen europæum* is, from its resemblance to the hand, revered everywhere in Anterior Asia under the name of "the hand of Mary," the *panja-i-miriam* of the Indian bazaars.

These are all direct indications of the phallic signification attaching to the hand in primitive times, as still among savage races. The signet hand is masculine, and emphatically so when represented "in *obscenum modum*," with the thumb and two outer fingers bent down to the palm, and fore and middle fingers raised, as in the conventional gesture of sacerdotal benediction; and the left hand is feminine, and emphatically when half closed. Derived from this phallic signification of the two hands was the identification of the right hand with the south, and the colour red, and with gold, and life, joy, glory, splendour, and supreme deity; and the left with the north, and the colours blue or black, and with death and disaster, and all the malignant powers of hell: whence also are women in some Christian churches still seated on the north side; and the general avoidance of the north side of graveyards for the burial of the Christian dead.* This symbolism undergoes certain modifications in India,† and in China is altogether reversed, but it holds true of the rest of the

* In India you must never enter a native house, or any room of the house, with your left foot first. You must always enter with your right foot first, and the neglect of this rule will often lead to the visits of ignorant Englishmen being avoided, as bringing ill-luck. But if invariably observed, you soon find yourself warmly welcomed, if for no other reason than that your presence is regarded as auspicious.

† At the recent Oriental Congress, a collection of Indian rings, formed by the Rajah Sir Sarendra Mohun Tagore, was exhibited by Dr. Leitner, who explained that the rings set with white stones were for Brahmans, with red for warriors, with yellow for agriculturists, and with black for "merchants and thieves." This allocation, which may perhaps afford a clue to the arrangement of the stones on Aaron's breastplate, was novel to me; but it is obviously based on the primitive Hindu colouring of the four quarters of the compass, the North or watery quarter white; the East or fiery, red; the South or earthy, yellow; and the West or windy, blue or black; the identical colouring of the ensign of the Peninsular and Oriental Steam Navigation Company. From time immemorial in anterior Asia the *elite* of an army has always been placed when in camp on the East side; and in India the West has from Buddhist times been pre-eminently associated with the international commerce of the country; and certainly all the "thieves" of India, English, Dutch, Portuguese, Afghans, Sassanian Persians, Greeks, Archæmenian Persians, and the Aryan Hindus themselves, have all come up out of the West; while the wind is the Master Thief of all! See my remarks on the breastplate of Aaron in the Society's *Journal* for 18th March, 1887, pp. 450-55; and the Preface to the 2nd Reprint of my "Report on the Old Records of the India-office." (Allen and Co., 1890.)

Old World. In the more ancient Hebrew manner of pledging good faith and fealty (Genesis xxiv. 2 and 9, xxxii. 25, and xlvii. 29, and compare also Revelation xix. 16) which is still observed in some parts of Arabia, we have the nexus between the hand as a phallic symbol, and a standard of exalted power, and the hand as a pledge of surety, and a sign manual.

The hand with the thumb and two outer fingers bent down, was, with other still more realistic representations of virility, used by the Romans as a "fascinum," and hence as a most potent "deus averrunculus." It is in this quality that the Jews in Palestine daub the old Phœnician phallic hand on their house, as quoted by Mr. William Simpson, from Major Conder, in the "Quarterly Journal of the Palestine Exploration Fund," for July, 1882. In the same Journal for January, 1877, I find Mr. C. F. Tyrerwhitt Drake writing:—"The hand print on the wall is commonly used by the Jews to avert the evil eye. . . . In the ruins of El Barid, near Petra, Professor Palmer and I found a cistern whose cornice was decorated with hand prints, alternately black and red. At the present day both [*sic*] Moslems, Christians, and Jews hang hands, rudely cut out of thin plate, of silver or gold, round the necks of their children, to preserve them from the evil eye." A hand carved in red coral, with only the fore and middle fingers extended, in fact a Roman "fascinum," is worn for the same purpose throughout the Levant; and an identical hand, but of metal or glass, or even paper, in Persia. It is the same hand with a different significance, which, in Persia is to be seen surmounting every mosque, and on the top of every standard; that is the "hand of Ali." In modern Italy both the apotrepic and the catarastic symbolism of the hand is found to be remarkably elaborated; and the left hand with only the thumb and little finger extended, once directed against an organ grinder will drive him from your front gate for ever.

"The Bloody Hand of the O'Neiles," or "Red Hand of Ulster," and "the Bloody Hand of the Holts," are, indeed, both associated in popular tradition with bloodshed and murder; but probably the "Bloody Hands of Heraldry" were all taken directly from the East during the Crusades, if not antecedently from Roman, Tartar, and Phœnician standards; and their origin having been forgotten, and men always striving after an interpretation, such legends as those of the O'Neiles and the Holts were invented to explain them.

Facts like these I have gathered here prove to us that, in its heart of heart, the world is very young yet; and the great fascination of India is, that the civilisation of the Old World is there still in its adolescence, as in its Greek and Roman prime. In his patriotic speech before the recent Oriental Congress of 1891, M. Gennadius, quoting Shelley, enthusiastically exclaimed:—"We are all Greeks; our laws, our literature, our religion, our art, have their roots in Greece." As literally true is it that we are all

Romans, all citizens of that world of equal laws, and settled peace and progress, so wonderfully created out of chaos by the supreme genius of Julius Cæsar, and reorganised, after the great cataclysm of the barbarians, on a Christian basis, by Charlemagne. But beyond the farthest "limits of Augustus," in India, Aryan society still solidly reposes, with no sign of variableness, neither shadow of turning, on its archaic ethnical basis; and thus preserve for us in daily living activity the true historical form and solution of those traditionary ritualistic and artistic types and symbols, and of those social and religious observances, the sense and purpose of which have long since become obsolete in the West. Beyond the perennial felicity they have secured to India itself—the India of the Hindus—this has been the high service of the Brahmanical priesthood to Western science and art, and—as I hope will yet be conceded—religion: and for this, who may begrudge them their guerdon of praise?

GEORGE BIRDWOOD.

5th Oct., 1891.

General Notes.

THE TEA TRADE BETWEEN CHINA AND RUSSIA. —Russia is regarded as the stronghold and mainhope of the Chinese tea trade; while the British islands are consuming Indian and Ceylon teas, and the United States those of Japan, to the injury of China, Russia continues faithful to Chinese teas. The Commissioner of Chinese Customs at Hankow, in his last report, says that the tea trade with Russia is increasing annually, while it is decreasing with England, because while in former years tea was shipped first to England and thence to Russia, the tea dealers in Russia now have their teas shipped direct from China. Last year the trade with Russia would have been very large if the supply of suitable kinds had equalled the demand. Only the better kinds of tea can now be sold in Russia at a profit, as the demand there has undergone a complete change. Between 1877 and 1888 the exchange of the Russian paper rouble was very low; good teas were therefore dear, and the mass of the people could only afford to purchase inferior kinds. Since 1888, however, the rouble has steadily risen, and has now reached a value higher than any of the past 15 years. Tea, with other foreign goods, became cheaper, and the people began buying tea of good quality, which, in spite of having cost higher prices in China, realised large profits. The market in China last year was entirely governed by the demand from Russia, which was very large and much in excess of the supply of the suitable qualities. In fact, the very best tea of the season (Keemums) sold very cheaply, simply because they are a kind not consumed in Russia. —*The Times*.

THE LIBRARY.

The following books have been added to the Library since the last announcement :—

Bailey, William.—The Advancement of the Arts, Manufactures, and Commerce; or Descriptions of the Useful Machines and Models contained in the Repository of the Society of Arts. Two vols. (London : 1772.) Presented by J. O. Chadwick, F.C.A.

Birdwood, Sir George, M.D., K.C.I.E.—Report of the Miscellaneous Old Records at the India-office. (London : 1890.) Presented by the Author.

Blackie's Elementary Text Books.—Elementary Mechanics. (London : Blackie and Son.) Presented by the Publishers.

Blackie's Science Text Books.—First Mathematical Course, Magnetism and Electricity, Light, Heat, and Sound, Geology. (London : Blackie and Son, 1889-90.) Presented by the Publishers.

Carroll, John.—Practical Geometry for Science and Art Students. (London : Burns and Oates.)

Coghlan, F. A.—The Wealth and Progress of New South Wales, 1889-90. (Sydney : 1890.) Presented by the Agent-General for New South Wales.

Danson, J. T.—The Wealth of Households. (Oxford : Clarendon Press, 1886.) Presented by the Author.

Dyer, Louis, B.A.—Studies of the Gods in Greece at Certain Sanctuaries recently Excavated. (London : Macmillan and Co., 1891.) Presented by Sir George Birdwood, K.C.I.E., C.S.I.

Earl, A. G., M.A.—The Elements of Laboratory Work. (London : Longmans, Green and Co., 1890.) Presented by the Publishers.

Emerson, P. H., B.A., M.B.—Pictures of East Anglian Life. (London : Sampson Low and Co., 1888.) Presented by the Author.

Finch, John.—To South Africa and Back. (London : Ward, Lock and Co., 1890.) Presented by the Author.

Fry, Herbert.—London in 1891. (London : W. H. Allen and Co.) Presented by S. W. Kershaw, F.S.A.

Gore, J. Howard.—Geodesy. (London : W. Heinemann, 1891.) Presented by the Publisher.

Guillaume, H.—The Amazon Provinces of Peru, as a field for European Emigration. (London : Wyman and Sons, 1888.) Presented by the Author.

Hanson, John.—Black Ash Waste and its Application to the Treatment of Sewage and Foul Water, a paper read before the Sanitary Congress, 1890. (Wakefield.) Presented by the Author.

Harris, William A.—A Technological Dictionary of Insurance Chemistry. (Liverpool : Published by the Author, 1890.) Presented by the Author.

Jago, William.—Inorganic Chemistry. (London : Longmans, Green and Co., 1890.) Presented by the Publishers.

Kingsbury, George C., M.D.—The Practice of Hypnotic Suggestion. (Bristol : John Wright and Co., 1891.) Presented by the Publishers.

Leland, Charles G.—A Manual of Wood Carving, revised by J. J. Holtzapffel. (London : Whittaker and Co., 1890.) Presented by J. J. Holtzapffel.

Mitchell, Charles F.—Forty Lessons in Carpentry Workshop Practice, revised by George C. Pope. (London : Cassell and Co., Limited, 1889.) (The Polytechnic Series.) Presented by the Publishers.

Mitchell, C. F., and E. G. Davey.—Forty Lessons in Engineering Workshop Practice, revised by J. Rogers. (London : Cassell and Co., Limited, 1889.) (The Polytechnic Series.) Presented by the Publishers.

Morris, I. H.—Practical Plane and Solid Geometry. (London : Longmans, Green and Co., 1890.) Presented by the Publishers.

Newall, Maj.-Gen. D. J. F.—The Highlands of India. Two vols. (London : Harrison and Sons, 1882-7.) Presented by the Author.

Notes on Building Construction. Part II. (London : Longmans, Green and Co.) Presented by the Publishers.

Ostwald, W.—Solutions. Translated by M. M. Pattison Muir. (London : Longmans, Green and Co., 1891.) Presented by the Publishers.

Philipson, John.—An Address on Technical Education at a Meeting held at Aberdeen. (Aberdeen.) Presented by the Author.

Richardson, B. W., M.D., F.R.S.—National Health. Abridged from "The Health of Nations." A Review of the Works of Sir Edwin Chadwick, K.C.B. (London : Longmans, Green and Co., 1890.) Presented by the Publishers.

Richardson, B. W., M.D., F.R.S.—Thomas Sopwith, M.A., C.E., F.R.S., with Excerpts from his Diary of 57 years. (London : Longmans, Green and Co., 1891.) Presented by Mrs. David Chadwick.

Saundby, Robert, M.D.—Lectures on Diabetes : including the Bradshaw Lecture, 1890. (Bristol : John Wright and Co., 1891.) Presented by the Publishers.

Société Industrielle de Mulhouse, Bulletin, 1883-91. Presented by P. L. Simmonds.

Spooner, Prof. Henry J.—Practical Plane and Solid Geometry, including Graphic Arithmetic. Vol. 1. Elementary stage. (London : Cassell and Co., Limited. (The Polytechnic Series.) Presented by the Publishers.

Trendell, A. J. R., C.M.G.—The Colonial Year Book, 1890, with an introduction by J. R. Seeley, M.A. (London : Sampson Low, Marston and Co., 1890.) Presented by the Publishers.

Veevers, Richard.—A Cruise in the Mediterranean. (Preston : 1890.) Presented by the Author.

Watt, George, M.B., C.I.E.—A Dictionary of the Economic Products of India. Vols. 3 and 4. (London : W. H. Allen and Co., 1890.) Presented by the Secretary of State for India.

Yeats, John.—Map Studies of the Mercantile World: the Golden Gates of Trade. (London : George Philip and Son, 1890.) Presented by the Author.

Journal of the Society of Arts.

No. 2,030. VOL. XXXIX.

FRIDAY, OCTOBER 16, 1891.

*All communications for the Society should be addressed to
the Secretary, John-street, Adelphi, London, W.C.*

Chicago Exhibition, 1893.

Forms of application for space, and prospectuses with detailed information, are, now that the Secretary has returned from Chicago, in preparation and will be sent out almost immediately. In the meantime, intending exhibitors can apply to the Secretary of the Royal Commission, Society of Arts, John-street, Adelphi, and their names will be noted at once, with a view to their receiving early copies of the prospectus when ready.

The Times has printed two long articles on Chicago and its Exhibition, by its correspondent in the United States. The first article refers entirely to the city and the second to the Exhibition. The following extracts are taken from these articles:—

The remarkable city of Chicago itself is the greatest marvel of rapid and substantial growth in the United States, and will be found by the visitor as much of a curiosity as any the Exhibition can show. This surprising municipality has all been created within the past 60 years. A long time ago the early French explorers built the little fort which they called "Chicagou" on the shore of Lake Michigan, and, about the beginning of this century, when hostile Red Indians roamed the broad Illinois prairies, the Government established a post at the mouth of the Chicagou river, which was named Fort Dearborn. In the Anglo-American war of 1812-14 these Indians were British allies, and they captured the fort, slaying the garrison, after it had been abandoned, when the Americans were retreating eastward to Fort Wayne on the Indian frontier. This

was before even a settlement was thought of here; but "the massacre" is one of the only two great events which, besides its rapid growth, have challenged attention in Chicago's history; the other was "the fire." The massacre marks a remote era for modern Chicago, which really dates from the great fire of 1871, an event that challenged the amazement and admiration of the world, having never been equalled in its magnificent scale of stupendous destruction and subsequent rapid and complete recovery.

The present intention is to formally dedicate the Exhibition on October 12th, 1892, the 400th anniversary of Columbus's discovery of America. Elaborate ceremonies will mark the event, the President of the United States being expected to attend, and a feature will be the procession, in which 10,000 troops will participate. The Fair is to be opened to the public on May 1st, 1893, and closed on October 30th following. The general reception of exhibits will begin on November 1st, 1892, although the installation of heavy machinery can proceed earlier; but no article will be admitted, according to the announced programme, after April 10th, 1893.

The location of the Fair is upon the south-western shore of Lake Michigan, in the southern part of Chicago, and about six miles from the centre of the city. Ample transportation services lead down to the site, by the steam lines of the Illinois Central Railroad, the cable tramcar lines of the "South Side" Railway on State-street and Wabash-avenue, and other railway accommodation already constructed on a liberal scale to carry an enormous suburban traffic. These are to be supplemented by additional railway routes now being arranged, and also by an ample steamboat service on the lake. There will be no trouble in transporting hundreds of thousands of people daily to and from the Fair. The chief buildings are located in Jackson-park, covering 586 acres, and they will front for a mile and a half on the lake shore. To get more room other buildings will be put on the Midway Plaisance, going westward to Washington-park, which will also be availed of. The display is to be divided into 13 departments, which are again subdivided into 172 groups and 917 classes, designated by numbers. The departments are designated by letters, and are as follows:—A, Agriculture; B, Viticulture, Horticulture, Floriculture; C, Live Stock; D, Fisheries; E, Mines and Mining; F, Machinery; G, Transportation Exhibits; H, Manufactures; J, Electricity; K, Fine Arts; L, Liberal Arts; M, Ethnology, Archaeology; N, Forestry. Elaborate preparations are making to accommodate all of these, whilst a few of them, being especially American industries, are expected to have a very large representation, particularly agriculture, live stock, manufactures, machinery, and transportation exhibits.

The enormous extent of the projected Exhibition is shown by the large dimensions of most of the buildings, which cover much more surface than ever

before at a World's Fair. Nearly all of them are to have sky-light roofs of iron and glass. Their walls will be covered with "staff," treated so as to represent marble, granite, &c., by which there will be a decided saving in cost, while the architectural beauty is enhanced. In the smaller State buildings, construction generally will be of native woods and stones, so as to display the varied resources of the country in building materials. There being such extensive lagoons on the grounds, with many fountains, and a strong fire brigade, arrangements are making for a large supply of water, capable of being expanded to 40,000,000 gallons daily, if necessary, capacious Worthington pumps, costing \$150,000, being placed on the grounds for this purpose, as part of the show. For the construction of permanent pumping works, the Exhibition authorities advance £40,000 to the city of Chicago, which will refund and take the works, and probably the pumps, for regular city supply after the Fair closes. The lake will furnish all the water needed.

A brief description of some of the larger Exhibition buildings will be of interest. The Administration Building—the finest at the Fair—consists of four pavilions, 84 ft. square, standing at each angle of its square ground plan, and connected by a great central dome 120 ft. in diameter and 260 ft. high. The centre of each façade has a recess 93 ft. wide, within which is a grand entrance to the building. The lower storey, comprising the pavilions, is Doric, 65 ft. high. The second, also 65 ft. high, is Ionic, being a continuation of the central rotunda, which is 175 ft. square. Above is the octagonal base, 40 ft. high, upon which rises the great dome. The interior effects will be very fine. This building far out-tops all the others. The enormous machinery exhibit will be placed in two buildings, with an attached Power-house. The huge Machinery-hall is to be constructed of three long and wide arched trusses side by side, and representing three long railway stations. These are to be built separately, the intention being to sell them after the Fair closes for railway train-houses, such structures being always in demand in this country of vast development. Each of the three elongated naves thus made will have travelling cranes for placing the machinery exhibits, and also the necessary lines of shafting. The Machinery Annexe, somewhat smaller, but of similar construction, adjoins to the westward. The separate Power-house will be for the steam-boilers, and will also contain engines and dynamos, provision being made to supply the largest amount of electrical power ever made. A number of steam-engines of various types will furnish 16,000 horse-power, operating the dynamos for light and power and driving the shafting. It is only in the Machinery-hall and Annexe that steam-power will be used. All the power elsewhere will be electrical, transmitted by wires from this Power-house. The 16,000 horse-power required here contrasts with the 6,000 at the Paris Exposition and the 1,456 horse-power Corliss

engine driving the machinery at the Philadelphia Exhibition of 1876.

The Agricultural Building, which is almost surrounded by lagoons, is severely classic in style. Its special feature is the five pavilions, one at each corner and one in the centre, the latter making a rotunda 100 ft. in diameter, surmounted by a glass dome 130 ft. high. The corner pavilions measure 64 ft. by 48 ft. The roof is chiefly of glass. The long Transportation Building is Romanesque, its interior being treated much after the manner of a Roman Basilica, with broad nave and side aisles. The roof is in three divisions, the middle one rising much higher than the sides, with a beautiful arcaded clerestory. The main entrance is an immense single arch, treated entirely in leaf, and called the "Golden Door." This leads to the central open space, surmounted by a cupola rising 165 ft., and reached by eight "lifts," which will be themselves exhibits. These carry visitors to the galleries running along the sides of the building. Adjoining, on the west, is the Transportation Annexe, a triangle of nine acres, consisting of one-storey buildings, each 64 ft. wide, set side by side. These will contain, in spaces 16 ft. wide, long railway lines, to exhibit trains of cars and engines. This display is expected to be stupendous, and hence the large space devoted to it. There will be at least 100 locomotives, arranged so that each will face a central avenue, making a fine perspective effect. Everything in the way of transportation is to exhibited, ranging from a baby carriage to a huge "Mogul" engine. The Horticultural hall faces east upon the largest lagoon, and has in front a flower terrace for an outside display, including tanks for nymphæas and the Victoria Regia. The front of this terrace, having a low parapet between large vases, borders the water, and has a boat-landing at the centre. The plan of this fine hall includes a central pavilion, with two end pavilions, each connected to the centre by front and rear curtains, thus forming two interior courts. These courts, each a parallelogram of a half-acre, will be decorated in colours and planted with ornamental shrubs and flowers. A crystal dome surmounts the central pavilion, 187 ft. in diameter and 113 ft. high, and under this will be the palm-house. The curtains will contain the hothouses and the plants under glass. There are galleries in the end pavilions, designed for *cafés*, being surrounded by arcades giving charming views over the grounds and the interior, which will present an attractive floral and horticultural display.

The Electrical Building is designed in Italian Renaissance, with entrances in each façade, and is 60 ft. high, covering over five acres. It will be ornamented by designs suggestive of the electrical display, with a statue of Benjamin Franklin, who is regarded as the pioneer of American electrical discovery, occupying a conspicuous position before the main entrance. The Fisheries Building is designed in Spanish Romanesque, contrasting agreeably with the classic architecture of the neighbouring buildings.

It is composed of three parts, and stands upon an island among the lagoons, which curves forward like a banana. The main structure has connected with it, by arcades, which curve outward at either end, a polygonal building 134 ft. in diameter, being thus thrust forward, and giving a concave front to the group, which has a most pleasing effect. In one of these polygons will be the water pool and aquaria, and in the other the exhibit of angling paraphernalia. The live fish display will be in a central basin 26 ft. wide, containing masses of rocks and aquatic plants; and also in ten large aquaria and a number of smaller ones, which will have a capacity for 140,000 gallons of water, and glass fronts 575 ft. in length, through which the fish may be observed in their native element. This will give the finest exhibition of the kind ever seen in the United States, the Government Fish Commission providing much of it. The main Fisheries Building will be devoted to a full exhibit of all the appliances used in the fishing industries of all countries and at all times. The extent of the display as designed may be imagined, when it is known that the extreme length of the structure, with its arcades and terminating polygons, is about 1,100 ft. The Mines and Mining Building is of classic architecture, its height being 65 ft. to the main cornice. There will be entrances on the sides, but the two grand entrances are placed at the ends, each 110 ft. high, and opening into a vestibule 88 ft. high. Each corner of the building is a spacious pavilion, surmounted by a dome, and the entire roof is of glass, elevated 100 ft. above the floor. This large structure is to contain a most interesting exhibition of the minerals and metals of the country, with the methods and appliances for mining and working them.

The Manufactures Building is the largest of all the structures, and, as seen from Lake Michigan, presents a broad front in the centre of the park. This building is made of two huge quadrangles, with corner pavilions and elaborate entrances on each façade. The structures surrounding the interior courts cover about eight acres, and the courts, which will be roofed over, have a surface of about 32 acres more, so that this enormous structure has a ground plan of some 40 acres. All of these buildings, with the exception of those devoted to machinery, are now in various stages of progress in construction; and the Women's Building, covering nearly two acres, has progressed far enough to be under roof. The United States Building, paid for by the Federal Government, and covering some three acres, and the Illinois State Building, provided out of the fund voted by that State, will be appropriate structures, adding much to the attractiveness of the grounds. The Fine Art Gallery is intended to be a perfectly safe repository for the art collection, and it and the United States Building will be, considering size, the costliest structures of the Fair. Many of the art exhibits herein contained will probably be bought for the permanent gallery Chicago intends establish-

ing after the Fair is over, as its memento. Among the paintings already here is Moro's picture of Columbus, executed in 1540, and bought in London to exhibit at the Fair. The Art Building is in reality a group of galleries. The chief structure is cruciform, with a nave 320 ft. long by 96 ft. wide, and transepts stretching 500 ft. The four exterior angles are filled in with lower constructions, thus making it a parallelogram 500 ft. by 320 ft., with a wide projecting portico in the middle of each side, the roof extending from all the cornices back to a central dome. Separated from this main gallery, and 100 ft. distant on the east and west sides, are two annexes, each 320 ft. by 120 ft. These annexes are brought forward, so that the whole group surrounds three sides of a court 300 ft. by 700 ft., which will be made an attractive feature. The Live Stock Building will be a very large affair, and \$150,000 will be devoted to prizes in this important department. It will be separate from the main group of structures in Jackson-park, as an extensive surface must be devoted to this exhibit in addition to the building. There is also to be provided, at a convenient part of the grounds, a Press Building, for use by correspondents and reporters, and the present scheme is to make it 200 ft. by 400 ft., as a large number are expected, the Chicago Press alone having quite a regiment of reporters. A protecting pier and breakwater have been extended into the Lake, above the landing pier, behind which the United States will make a naval exhibit. A model of a coast defence battle-ship is being constructed upon a stone foundation for this part of the show, so as to observe the treaty with England, and a naval training-ship is to be brought here with a full complement of boys. It is also stated that the model of the *Victory* from the Chelsea Exhibition is to come to Chicago. A *fac-simile* is now being built in Spain of the little caravel *Santa Maria*, in which Columbus sailed on the fateful voyage that discovered America. She will first appear at the naval review in New York Harbour in October, 1892, and be afterwards taken up the Lakes to Chicago. The final resting-place of this little vessel will be at Washington. Among the other curious exhibits at the Fair is a Californian project. A gigantic red wood tree is to be cut down, which is 390 ft. high and 26 ft. in diameter. From this a log will be cut 90 ft. long and 20 ft. through. This being cut into two 45 ft. lengths, each is to be hollowed out, and fashioned into a full-sized railway coach, the interior being fitted in the style of a Pullman coach. One will be a sleeping coach and the other a dining car, with kitchen, restaurant, bath, and barber's shop. Finally, to show the entire bigness of Chicago, which out-tops almost all things, and is to do this especially in the Fair, three responsible citizens propose to erect a tower 1,200 ft. high, at a cost of £400,000, which will rise higher and is to be seen further than the tallest structure yet shown at any World's Fair.

Proceedings of the Society.

CANTOR LECTURES.

THE DECORATIVE TREATMENT OF NATURAL FOLIAGE.

BY HUGH STANNUS.

(Lecturer on Applied Art at University College.)

[THE RIGHT OF REPRODUCING THESE LECTURES IS RESERVED.]

*Lecture II.—Conventionalism. — Delivered
27th April, 1891.*

§ 10.—REALISM: COMPLETE.

In the Complete or Pictorial Realism: the Chief object is represented with the utmost fidelity to the actual appearances. The Growth is drawn from the individual branch, in all its accidents of malformation, abnormal growth, or mutilation; the positions of leaves and flowers are rendered without regard to the *mass-shape* of the whole, or the *foreshortening* of portions; and the Light-and-Shade, and the Local-Colour, with Reflections and Accidental-lights, are included; making the painting a perfect Portrait of the chosen object. The Surroundings or Fore-ground-objects (if any), and the Background (be it landscape or otherwise) are also included; making the whole a complete Picture. It might be painted on a Furniture-panel, without the regulation gilt Frame: it would still be a Picture.

An example of this might shew a group of Flowers in a Vase, placed under an Arch, through which is seen a Landscape background. In this, it would be observed that:—(1) the whole is in perspective, and that the Point-of-sight is not on the axis or centre-line of the picture; (2) the Chief-object (the Flower-vase) is not axial in position; (3) the Vase is not parallel to the Picture-plane, as shewn by the handles and plinth; (4) the Flower-mass is not axial with the Vase, but leans over on one side; and (5) a portion of the Flowers is cut-off by the window-opening. Each of these treatments is contrary to the usually-accepted Canons of Decoration; and the combination of them is appropriate to the Realistic or Pictorial Method. All Pictures are executed in this method.

§ 11.—REALISM: SEMI-PICTORIAL.

In this second treatment the Chief-object and the Foreground-surroundings are still as realistically represented as in the first, except

that malformation and abnormal growth are omitted; but the Background is reduced from realism to the Conventionalism of a Flat-tint of colour (including gilt or similar grounds in this category). Hence the painting is still a perfect Portrait of the chosen objects; but it is not a Picture. It might be painted on canvas and placed in a gilt frame: it would still be something less than a Picture, and would lie in the borderland between the Pictorial and Decorative Arts.

An example of this might shew:—(1) The whole to be still in Perspective, but the Point-of-Sight is now in the axis of the window-opening; (2) the Chief-object is axial in position; (3) the Vase-plinth, &c. are parallel; (4) the Flower-mass is almost axial and symmetrical; and (5) no portion of the subject is cut-off by the Window-opening. Much of the more elaborate Mural-decoration (in Painting and in Tapestry) is executed in this method.

§ 12.—REALISM: DECORATIVE.

In this third treatment, the Chief-object (*only*) is realistically represented, as in the two preceding; but everything else is reduced, in character, to a Conventional representation. It will be observed that the Chief-object is the sole survivor of the Realism. This is a "Survival of the Fittest"; and it is obvious that if the higher treatment be retained—it should be applied to the higher object. Realism is very appropriate and effective, in this manner, imparting an added charm to Decorative work; serving (so to speak) as the Jewel of the setting, or the Focus of the composition. It can never raise the work to be Pictorial; it might be painted on any surface: it would still be Decoration.

An example of this might shew:—(1) There would be no Perspective, but everything would be in Elevation; (2) the Chief-object is axial as in the second; (3) the Vase is severely drawn in elevation; (4) the Flower-mass is axial as before; (5) no portion is cut-off; and (6) the Arched-opening is replaced by a Colour-margin which is separated or divided from the inner panel by a thin tendrill of Artificial Foliage (as in Louis XVI. work). Most of the more elaborate foreign Furniture-coverings in Brocade-silk and Tapestry are from designs executed in this method.

It will be observed that there is—corresponding to the gradual reduction of Realism—a gradual increase in Artificial Arrangement. Thus the position and attitude of the

Vase, and the mass and grouping of the Flowers, become gradually more severe as the work gradually loses its Pictorial character.

§ 13.—APPLICATION OF REALISM.

Realistic representations have their place in the following Positions and Objects :—(a) Important positions, *e.g.* the centre of a Wall, or a Cabinet ; (b) Non-functional portions of objects, *e.g.* panels ; (c) Moveable objects,

e.g. Pictures ; and un-folded Drapery, *e.g.* Tapestries, and figured Brocade-silks whose evident cost is an excuse for their aim at Realism, and will also prevent their being lavishly applied, &c.

Realistic representations, in any of the three degrees of realism, should be *unical*, *i.e.* should not be repeated in the same design. When there is Repetition, and it is produced *by hand*, *e.g.* in Embroidery—it would be

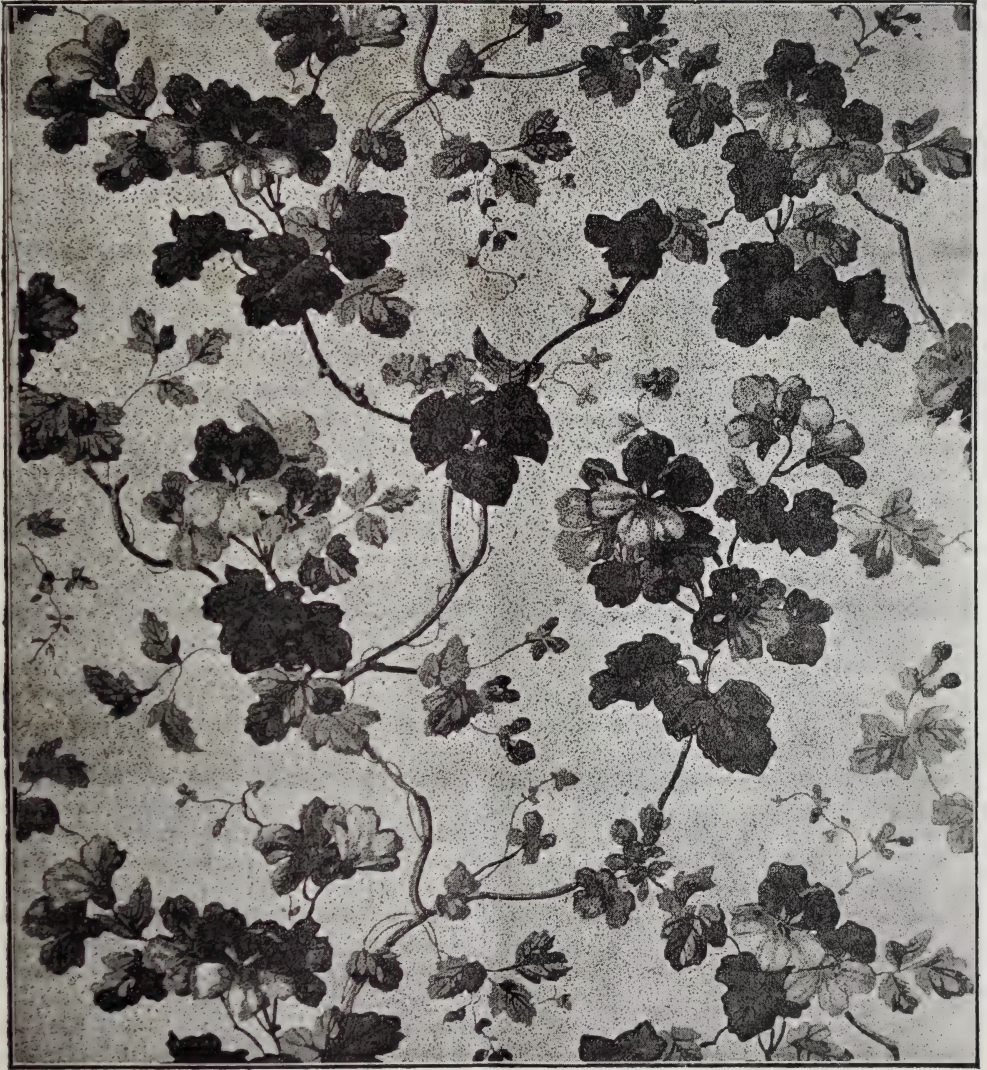


FIG. 6.

treated in the second or third degree of realism ; and more effort to imitate the appearance of Nature would be allowed, because the details would be each individualised and all varied by the Worker.

When, however, the repetition is mechanical—the details should be generalised. If the spectator were to observe a highly realistic portrait of a flower on a wall ; and, a few inches distant, see another, exactly similar in every

respect ; and so on all over the wall—his attention would have been raised for nothing ; and he would be disappointed. The example, fig. 6 (p. 875), is one of the best and least objectionable of these. It is only a matter of regret that a clever Artist should occupy his talent in the effort to make a repeating Print emulate a water-colour Picture.

§ 14.—CONVENTIONALISM.

In the absolute or Ultimate Conventionalism : the whole of each object is represented in Outline (*only*). There are, however, Degrees in this reduction, from the Complete Realism of § 10 to the Absolute Conventionalism of § 18, corresponding to the reduction in the available appliances ; and these are shown in the Chart in § 9.

The Student has doubtless read of some early Levantine Trader being met, on his return voyage, by a continuous spell of tempestuous weather, who casts overboard successively, portions of his cargo in endeavouring to make the port with the remainder—how in the Mediterranean, he throws overboard his heavy tackle—by Gibraltar, the dried fruits—in the Bay, his Coffee—in the Channel, the Embroidery—and by the Goodwins, the Silks—the Sapphires and Rubies being the sole surviving results of his venture. So he can imagine the Decorative-artist losing in succession his Appliances—how he cannot execute his work by his own hand, but must trust to others—he cannot have hand-work, but must trust to mechanical reproduction—he cannot have all the varied colours of Nature, but is reduced to a limited number—he cannot give varied colour, but only monochrome gradation—he cannot give gradation, but only flat-tint—the Outline being his sole surviving servant.

With this gradual “throwing-overboard of the Cargo” or lessening of Appliances—two results ensue :—(i) On each lessening of his Appliances, the student will make *less ambitious* efforts ; (ii) on each loss of any Appliance or method of expression, he will develop *more acutely* those which yet remain. It is observed, in the domain of Sensation, that those who have lost Sight become more acute in Hearing and Touch : so also in the domain of Art the absence of complete Realism is compensated by accentuation of the Characteristics ; and the loss of Colour or Light-and-Shade is replaced by clearness in the Drawing (see § 18).

§ 15.—CONVENTIONALISM : FIRST DEGREE.

The first degree of Conventionalism results from either of the two restrictions in available appliances shewn in the Chart at § 9.

Of the former loss (*a*)—in the number of available pigments—some of the Japanese pictures are good examples. In one such, the Artist has been limited to three Pigments—Black, Grey, and Fawn—with which he has represented a Bird in Water among Flag-Lilies. He has shewn the Bird with Grey and Buff, using the Black for its eye, beak, and heightening touches ; in the water, and leaves, Grey is chiefly used ; and the flowers are represented in Black, with buff pencilling. This is a very characteristic example : the Artist was probably impressed by the striking effect of the strong Blue of the flowers, as the *most important* feature of the whole ; and he used his Black (a nearly related pigment) as the best substitute that was available. This is not Realism, inasmuch as Black is substituted for Blue ; but it is good Conventionalism.

Other examples of working with a restricted palette are found in Majolica-ware. There the available pigments were a matter of Chemistry ; and the only ones then at the disposal of the Potter were a Blue, the two tints of Siena, a Green, a Black, and the two Lustres of Maestro Giorgio.

In the latter loss (*b*)—of Gradation and Shading, the flat tints of Pigments only being available—most of the Wall-papers used in houses are good examples. In studying them, it will be observed that when the Artist is reduced to Flat-tints of colours, his ingenuity is taxed to give the necessary Clearness. In the simplest method of using flat-tints (*i.e.* the Blot-method) he might use different tints for the different parts of the plant :—*e.g.* a pink for the flowers, a green for the leaves, and a brown for the stems. This, while it would give the general shape or mass of each part, would be found inadequate to give the inner drawing and details ; as may be seen in fig. 7 (p. 877).

The leaf may therefore be represented as in fig. 8, *i.e.* in separate pieces with the ground shewing-through. It might be objected—that the real leaf is not in separate pieces : but to this it would be replied that—when judiciously done, the eye takes-in the several parts as one whole ; and that this is one of the concessions to technical limitations which are the truest Conventionalism.

The ground which shews-through between the separate parts of a leaf, will be seen to vary in breadth. When it represents the Veining of a leaf or the Pencilling of a petal—it is narrow and tapering, for the purpose of suggesting the relative breadths in Nature. When it gives the drawing of different portions

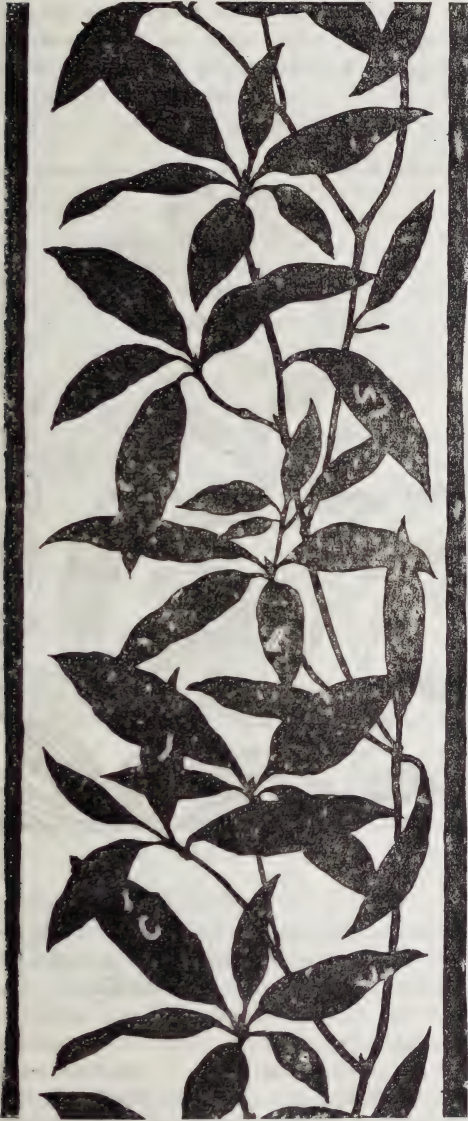


FIG. 7.

of the same leaf, *e.g.* when the leaf turns-over—it is rather wider. When it separates one leaf from another, or one part overlapping another—it is still wider; as shewn in fig. 11 (p. 879). This method—of shewing the ground between the parts—is termed “Voiding”, from the practice in Heraldry.

Two flat-tints may be effectively used, as is shewn in fig. 9 (p. 878), in which the first tint gives the Mass-blot, as in fig. 7; and the second tint gives Local-colour or Shadow. This second tint must be so disposed as to assist the drawing by making dark portions of one leaf against light portions of another. The



FIG. 8.

second flat-tint may also be used to give Texture, on the fruit, flower, leaf, or stem.

Another manner—of using two tints for Leaves—is suggested by the Japanese. In Nature the upper-surface of a leaf is nearly-always shiny; and of a darker green than the under-surface, which is grey, and dull.

This is admirably shewn in fig. 10, in which the shiny and dark upper-surface is represented by a black blot, with voided veins; and the under-surface by a grey blot, with outline veins.



FIG. 9.

The Outline (which in ultimate Conventionalism is the sole survivor) is often very useful when superadded in the intermediate degrees, not only for Clearness-of-drawing and Distinctness-of-pattern, but for Colour, and Breadth. A yellow outline adds luminosity; a pink or

light-blue one adds a bloom; and a brown one adds a sombre tone. Each of these is valuable in its place; and an outline of the proper tint will often harmonise harsh and discordant colours; and thus give Breadth and Softness to the whole. An outline, of any tint, has the effect, of *attaching* the pattern to the ground, thus giving Steadiness; and further, of recognising the Surface; as is shewn in fig. 11 (p. 879).

Sometimes, when there are *two planes* of foliage in a pattern—the foliage in front is outlined, and that in the rear is left in the blot; as is shown in fig. 12 (p. 880).



FIG. 10.

§ 16.—CONVENTIONALISM: SECOND DEGREE.

The second degree of Conventionalism results from either of the two restrictions in available appliances shewn in the Chart at § 9.

Of the former reduction (c)—to gradated Monochrome in Colours—some of the painted Fans are good examples. In one such: the Artist, working on a ground of Black silk, has represented the principal group of Flowers in realistic colours; but those which are on each side are represented as gradually fading, or "*losing colour*", until those at the extreme end are painted in tints of Grey-monochrome. The Light-and-shade and the Gradation-of-tone are kept; but, the Colour being *lost*, the effect is Conventional. In another such Fan, the ground being Red, the side flowers gradu-

ally "lose" their proper colours, until they are represented in Red-monochrome. In both of these instances the fading is towards the Monochrome-scale of the Ground-colour. It will be observed in the given instances that the particular treatment has been adopted, not from technical but from *æsthetic* considerations, as an artistic modulation to the colour of the ground.

This practice often occurs in Decorative painting, in which the different portions are represented in monochrome-scales of different colours; and also in chintz-patterns, in which the so-called "Autumn tints" are often used. Sometimes tints which are accurate in regard to Gradation are arbitrarily substituted for the natural colours. This often arises from the Artist's sense of inability, with a restricted



FIG. II.

palette, to emulate the beauty of Nature—a failure which is less apparent in the *arbitrary* than in the natural colours.

Sometimes in Diapers on Wall-papers the pattern is *Duplex*, i.e. there is a Front-pattern in strong colouring, and a separate Rear-pattern in softer colouring. In these cases the colour of the Rear-pattern is often printed in a darker tone of the Ground-colour, or some intermediate tint between that and

the colours of the Front-pattern. This is an analogous case of modulation to the Ground-colour.

Of the latter reduction (*d*)—to gradated Monochrome in Black-and-white—most of the Limoges enamels are good examples.

It has not been practicable, owing to absence of colour in the reproduced illustrations, to give examples of these; but the Student may see many in the Museums.

§ 17.—CONVENTIONALISM : THIRD DEGREE.

The third degree of Conventionalism results from the further restrictions in available appliances shewn in the Chart at § 9.

The two restrictions—(e) to one flat Mass-tint on a ground of another flat-tint, or (f) to a black Mass-tint on white—have, practically, similar results; and the same treatment, so far as Conventionalism is involved, may be applied to both.

A pattern in the third degree of Conventionalism is given in fig. 13. It will be observed that all parts of the plant—fruit, leaves, and stems—are in one flat-tint or Mass-blot; which has a somewhat dull effect.

Variety of appearance, and nearer approximation to Nature, may be produced by combining the two methods—of the Mass-blot, and the Outline—as shewn in fig. 14. In such a

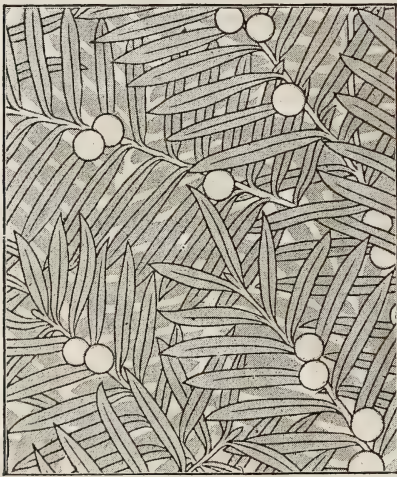


FIG. 12.

treatment, the Flowers or Fruit should be represented by one method, and the Leaves and Stems by the other.

The particular method, to be adopted, depends on the local colours of the Plant and that of the available Flat-tint. When the Pomegranate is used, the local colours are yellow for the Fruit, and green for the Leaves and Stems. If, therefore, the available Flat-tint be *yellow*: then the (yellow) Fruit should be in mass-blot, and the (green) Leaves, &c., should be in outline; as shewn in the upper half of fig. 14 (p. 881). If the available Flat-tint be *green*: then the (green) Leaves, &c., should be in mass-blot, and the (yellow) Fruit should be in outline, as shewn in the lower half of the

diagram. The difference will be observed on comparing fig. 14 with fig. 13.

Generally: the relative tone of Flower or Fruit with Leaf, and the Flat-tint which is to represent them, must be all considered, with reference to each other and to that of the Ground-colour.

When the Leaves, in dark mass-blot, can be



FIG. 13.

arranged to lie in part behind the outlined Flowers, then they will serve the purpose of "forcing-up" the brightness of the Flower; and making it to appear brighter than the ground, though of the same tint, and thus more effective.

The foregoing designs are reproduced *positively*, i.e. the pattern is *added* to the ground.

Occasionally, designs are reproduced *negatively*, i.e. the pattern is *cut-out* of the block which prints the ground, and is thus voided; as is shewn in fig. 15 (p. 882).

This Negative method is an addition to the resources of the Pattern-artist. It may be combined with the Positive method; and produce a good result; as is shewn in fig. 16 (p. 882).

§ 18.—CONVENTIONALISM: ULTIMATE DEGREE.

The fourth and ultimate degree of Conventionalism results from the severe restrictions in available appliances shown in the Chart at § 9. These two restrictions—(*g*) to Outline of several colours, and (*h*) to Outline of one colour (*only*)—bring the pattern-artist to his



FIG. 14.

last resources. To Outline, as the last survivor, must he trust for his effect; and here the necessity of careful study, in order to compensate for the loss of all else, as mentioned in § 14, is most strongly felt.

Of the former reduction (*g*)—to Outline in *several* tints—the “Homeric Marbles” at University College are a well-known example. Here the drawing of the various figures is engraved or incised on various pieces of

marble, and the lines, of hair, drapery, &c., are filled-in with different colours, giving great clearness. Most of the beautiful Leek em-

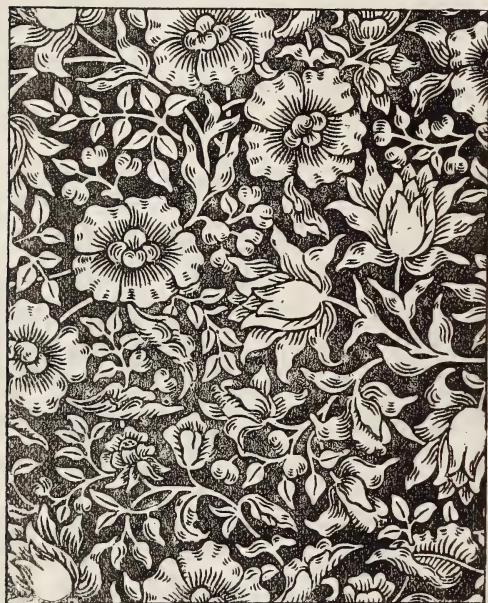


FIG. 15.

broidery is outline (*only*) in various colours. These lines of v ins, &c., give the effect of a *Tint*, by the Suffusion of the colour-of-the-



FIG. 16.

lines over the ground, as mentioned in the Theory of Colouring.

Of the latter reduction (*h*)—to outline in one tint—the so-called “Flaxman Outlines” to the

Iliad are a well-known example. Fig. 17 shews an impression of the Outline-block of the pattern given in fig. 12. It was not designed as an “*outline pattern*” (*i.e.* one in which the outline is the *only* means of producing the pattern), but as the outline of a tinted pattern; hence it is not so carefully considered and developed as in fig. 19 (p. 883), which is for *outline only*.

In Outline-work the Student should search for and emphasise the difference in drawing between the different parts of the plant. He may exaggerate the serrated edge of the Leaf, to distinguish it from the delicately undulated Petal-edge. Departure from the Reality is condoned if the pattern be good. It should be borne in mind that the end is—

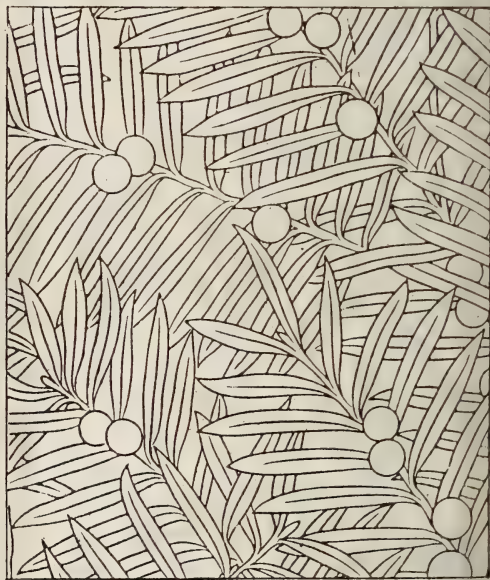


FIG. 17.

not a Botanical diagram, but—a Pattern. There are, however, degrees in the amount of this exaggeration; and if it be detected, then the Student should remember that the Spartan boys were punished, not for the theft, but—for their clumsiness in being found-out.

Variety in breadth of the Outline is another resource yet remaining to the Artist. There are other qualities of line, *e.g.* Texture; but they are scarcely amenable to the severity of ultimate Conventionalism. With the help of varied breadth, however, a clear and artistic effect may be produced, even in outline.

There are two systems by which the variety-of-breadth may be regulated:—(i) The Light-and-shade system, under which—a weak line

was used on the light side or edge of objects, a medium line on the side parallel to the picture-plane, and a strong line on the darker side or edge: it was much used in Architectural and Engineering drawing twenty years ago; and was termed "Back-lining"; but

spectator, and a strong line for those objects or parts of objects which are nearest, in direct ratio to distance or nearness: this with the further development from it—of drawing the mass-line (or line which circumscribes each mass or object) a little more strongly than the



FIG. 18.



FIG. 19.

has latterly been discontinued; it is a vicious system, and an attempt to achieve more (*i.e.* Light-and-shade) than the available Means (*i.e.* outline) will permit. (ii) The Mass-line system, under which—a weak line is used for those objects which are farthest from the

inner lines of that particular mass, each being graduated according to the distance or nearness—was systematised by the writer about twenty years ago. Fig. 18 shews a design in which the outline is all of approximately *the same breadth*; and fig. 19 shows the same

design with the foremost leaves *mass-lined*: it will be obvious that the latter is the more effective.

§ 19.—NOTE ON CONVENTIONALISM.

The Student will perceive that Conventionalism lies—not in changing the natural growth to some preconceived idea of his own, but—in rendering all the beauty which is possible with the limited technical means at his disposal.

Also that the expression:—"conventional foliage" is as meaningless as the other:—"natural representation": the correct statement being that the *kind* of foliage is "natural" or otherwise, and the *method* of representation is "conventional" or otherwise.

He will further perceive that *limitation* of Means does not necessarily involve *stiffness* of Attitude; though some have so associated the two ideas that the word "conventional" has fallen into bad repute. With all the loss and restriction of Means, there will always remain the power to DRAW; and thus to endeavour, however insufficiently, to utilise some of that infinite wealth of Beauty which lies around.

Miscellaneous.

AGRICULTURAL AND MINERAL DEVELOPMENT OF COLORADO.

M. G. C. de Bronkart, Belgian Consul at Denver, calls attention, in his last report upon the condition of Colorado, to the advantages offered by that State to intending emigrants: advantages as much from an agricultural as a mining point of view, both agriculture and mining having combined to make this young State one of the richest and most important of the American Union. Taking agriculture first, M. de Bronkart says that, only a few years ago, Colorado, in the opinion of foreigners, and even of residents of the United States, passed for a perfectly arid district; and this State was dependent upon the States of the centre, the north-east, and the Pacific for all the vegetables and fruit required for its consumption. By means, however, of numerous irrigating canals, of a total length of about 34,000 miles, which have been constructed, and which have cost over 10,000,000 of dollars, the condition of Colorado has been completely changed, and, as stated above, it has become one of the principal producing States of the Union. Colorado has an area of 104,500 square miles, of which 54,000, or

34,500,000 acres, are capable of irrigation. The irrigated lands are found under better conditions, and produce more than those which only receive rain water; for example, in San Louis valley there is a yield to the acre of 88 bushels of wheat, 112 bushels of barley, 118 of oats, and 847 bushels of potatoes. This is the yield of an exceptionally good year, but the average production may be estimated as follows: wheat, 35 to 70 bushels to the acre; barley, from 40 to 90; oats, from 40 to 95; and potatoes, from 200 to 700. The principal product, however, of Colorado, is alfalfa, or lucerne; and thousands of acres are sown with it. Lucerne is cut three or four times, and the yield is from 5 to 8 tons per acre and per year. One of the most important crops, however, in the opinion of the Belgian Consul, is beetroot: of this over 80 tons have been produced to the acre; and the question of creating a large number of sugar factories in many districts of the State is now under consideration. In addition, it has been proposed to give bounties to beetroot growers, in order to encourage an extension of the present cultivation; and a Bill on the subject is likely to pass the State Legislature. The bounty which it is proposed to grant would be at the rate of one halfpenny per pound of beetroot sugar manufactured in the State. Already other States, such as California, Utah, Kansas, New Jersey, and Nebraska are in the enjoyment of bounties for the cultivation of beetroot. The cultivation of fruit trees has been considerably extended during the last few years. Colorado produces every description of fruit, such as apples, peaches, pears, apricots, grapes—the latter in surprising quantities. At the same time, as the production of fruit increased, the industry of preserve making has kept pace with it; and from this industry much is expected. Another industry, which is rapidly extending, is that of honey production. The yield last year was far in excess of earlier years; and whole truck loads were sent from the counties of Weld and Boulder. It is, however, in the absence of reliable returns, impossible to estimate the total quantity produced. As regards the mineral wealth of the State, the value of gold produced in 1890 amounted to £902,000; silver, £4,051,000; lead, £949,000; and copper £71,000. Iron mines abound in all parts of the mountainous districts of the State, but it is principally in the South that the iron industry has experienced the greatest development. According to competent authorities, the county of Gunnison, in the south of Colorado, contains alone more hematite iron than the entire State of Pennsylvania, and the cost at Colorado is 2s. a ton lower than at Pittsburg. At White Pine, near the city of Gunnison, on the slope of the mountain, there is an immense vein, the extent of which it has not hitherto been possible to estimate. Several open workings have been commenced over a distance of about a mile, and one of the openings has shown 40 feet of compact iron ore. At Gold-hill, to the north-east of the city of Gunnison, there is another deposit of

iron of the same importance, and there are also others near the Ceballa river, to the south-west of the town. The value of the production in 1890 amounted to £300,000. Owing to the construction of new lines of railway, numerous coal mines have commenced working, and the production has considerably increased—from 2,400,000 tons in 1889, it rose to 3,075,000 tons in 1890. Bituminous and semi-bituminous coal is principally found in the north of Colorado, in the counties of Fremont, El Paso, Huerfanos, Las Animas, La Plata, Pitkin, and Garfield. Vast beds of anthracite are found at Crested Butte, in the county of Gunnison. The price paid for labour in extracting the coal is about 3s. a ton, and the average price of the coal loaded on trucks is about 6s. 3d. It is estimated that, before the end of the present century, the coal trade of Colorado will represent a value of over ten millions sterling. The production of coke is about 200,000 tons. Although ten years ago Colorado was the smallest of the American States as a producer of building materials, she now supplies not only her own requirements, but sends vast quantities of granite and marble to the principal Eastern cities. Considerable deposits of marble of a superior quality have been discovered, and several quarries are being worked. The production of petroleum in Colorado in 1890 was 12,500,000 gallons, and this quantity is increasing daily.

UNITED STATES COAL PRODUCTION.

A bulletin on the production of coal in the United States has recently been issued from the office of the Superintendent of the Census at Washington. It shows that the coal product of the United States reached a total of 141,229,513 short tons in the census year (1890), and was valued at the mines, before any expenses for shipment, at over 160 million dollars. During 1890, coal was mined in thirty-one States and territories, including Alaska and Rhode Island, although the product of the latter is not adapted for fuel, and is therefore only mined to a limited extent for industrial purposes. Pennsylvania, containing the wonderful beds of anthracite as well as extensive deposits of bituminous coals, yielded 58 per cent. of the entire output of the country. Illinois, with bituminous deposits, only ranks second as a coal producer, Ohio, West Virginia, Iowa, and Alabama following in the order named. The anthracite coal-fields of Pennsylvania are confined to the following counties in the north-eastern part of the State:—Casbon, Columbia, Dauphin, Lackawanna, Luzerne, Northumberland, Schuylkill, Sullivan, and Susquehanna. The area of the entire region is about 1,700 square miles. The area underlain by workable coal-beds is only about 470 square miles. The Appalachian bituminous field lies immediately west of the eastern frontier of the Appalachian mountains, and extends from New York on the north

to Alabama on the south. Its length is a little over 900 miles in a north-east and south-west direction, and its width varies from 30 to 180 miles. It covers western Pennsylvania, south-eastern Ohio, the western part of Maryland, nearly all of West Virginia, the eastern part of Kentucky, a portion of Eastern Tennessee, part of Georgia, and part of Alabama. All of the coal in this field is bituminous, and is of great variety, both in chemical composition and physical structure. The best and most productive coal-beds lie in the Pittsburgh district and in West Virginia. What is known as the eastern triassic area is composed principally of the Richmond basin in Virginia, and the Deep river and Dan river fields in North Carolina. The first coal systematically mined in the United States was taken from the Richmond basin. In 1822 about 48,214 tons were produced, which was twelve times the total amount of coal shipped during that year from the Pennsylvania anthracite region. The maximum production of the field was in 1833, when 142,587 tons of coal were shipped. A deposit of graphitic coal, sometimes called anthracite, underlies portions of eastern Rhode Island and the counties of Bristol and Plymouth in Massachusetts. The product, however, has been limited. The northern bituminous area is confined exclusively to Michigan, spreading over the central part of that State. Many coal-fields are found within the area of this field, which has been computed to be 7,000 square miles. The numerous transportation routes, both by water and rail, to the more distant coal-fields containing better coal, has militated against the development of the Michigan coal-basin. The central field includes the coal areas of Indiana, Illinois, and Western Kentucky. On account of Illinois containing the most important part of the field, it is frequently called the Illinois field. The portion of the field in Illinois is over five times as great as that in Indiana, and over nine times as great as that in Western Kentucky. The Western field embraces those coal-fields west of the Mississippi river. It is embraced within Iowa, Missouri, Nebraska, Kansas, Arkansas, Texas, and the Indian territory. The most extensive mining operations in this field are carried on in Iowa and Missouri. The best coal which has so far been mined in the field is that from Indian territory. The area of this field is greater than any other coal-field in the United States. The coals are of great variety, and the region under which they lie is a rich agricultural country. In the Rocky Mountain region coal-beds are found in a number of geological formations. In the fields above referred to, with the exception of those in Virginia and North Carolina, the coal-beds belong to the carboniferous age. No detailed information of the entire coal area of the Rocky Mountain region is available, and no reliable estimates have been made of the areas underlain by workable coal-beds. It has been surmised that the total area of the coal-fields of this district is between 200,000 and 300,000 square miles. The anthracite coals of

Colorado and New Mexico are of superior quality, and apparently in ample supply for the rapidly increasing demands. In the Pacific Coast region coal has been mined in Washington, Oregon, and California. As stated above, the total product of coal in the United States during the calendar year 1889, as reported in the eleventh census, was 141,229,513 tons, as compared with 71,481,570 tons in 1880. The value in 1889 was 160 million dollars, and in 1880 96 million dollars. The amount produced in 1889 includes 45,600,487 tons of Pennsylvania and other anthracite, and 95,629,026 tons of bituminous and lignite. The amount of capital invested in coal mining in the United States in 1889 was 342,757,929 dollars, or £71,407,901.

THE INDIA-RUBBER INDUSTRY OF DUTCH GUIANA.

The caoutchouc, or india-rubber, is produced in Dutch Guiana under different species, the most important of which is "balata" or "milk of the bullet tree," the export of which, says Consul Wyndham, of Paramaribo, is attaining considerable proportions, and will, it is believed, be very productive for a time only, as there is no forest conservancy law in the colony. Persons who are granted tracts of land for the gathering of this product are uncontrolled in their method of drawing the milk, which results in trees being totally destroyed to get the greatest amount of milk by the quickest and most inexpensive method. The district where the largest quantity of "balata" trees are known to exist in the colony is that bordering on the Correntyne River, known in Dutch Guiana as the "Nickerie district" and large tracts of land have been given to an English firm to collect balata. Balata is treated by the manufacturers simply as a superior kind of gutta-percha, and therefore its name disappears when manufactured; nevertheless balata is distinctly different from gutta-percha, and this is manifested in some of its physical characters—for instance, it is somewhat softer at ordinary temperature and not so rigid in the cold. Besides the bullet tree, there are trees or plants known as the *Tonckpong*, which gives a valuable rubber, and again *Bartaballi* and *Bushrope*, to which collectors do not appear to have given a name. The india-rubber balata industry, although carried on in the colony of Dutch Guiana in a desultory way for a long time, has never until quite recently assumed sufficient importance to cause the local government to legislate upon it. As yet the law only lays down the regulations under which concessions are granted, and does not deal with the supervision or treatment of the trees, or the method of extracting the milk. Caoutchouc or india-rubber is yielded both by trees and vines. Those already mentioned are, as far as it is known, the principal ones in the colony, and the method of collecting the milk is by cutting down trees, by incisions, and by circling the tree. In each case there is no protective

law, and the trees are generally ruined. The chief port of export is Demerara, and as yet no export duty exists, but as the production increases it is expected that it will not escape taxation. Nothing has been done to cultivate the plant, neither does the soil seem to favour its growth except in some peculiar circumstances. Consul Wyndham says that new laws are contemplated for the leasing of lands to prospect for balata. An article on the "Balata Industry," taken from the report of Mr. G. S. Jenman, Government Botanist, British Guiana, will be found in the *Journal*, vol. xxxiii, p. 923.

General Notes.

FOREIGN TRADE.—Recent Consular reports from Italy and Japan have referred to the loss of trade owing to firms in England sending to those countries circulars and price lists based on the English weights and measures. The metric system is used in those countries, and our French, German, and other competitors use it in their quotations, but the English firms in question are content to puzzle buyers with weights and measures which are very troublesome and not understood. A similar complaint now reaches us from Egypt in a Consular report just issued, which points out that our weights and measures are "utterly unintelligible" to a large proportion of the persons to whom export houses in this country forward their circulars and price lists in Alexandria and Cairo. The metric system of weights and measures is in force in Egypt, and exporters of English goods to that country should adopt it in their quotations and transactions.—*The Times*.

TERRA-COTTA.—In an article in *The Building News* are given analyses of some of the extensively worked terra-cotta clays; and the following remarks are made in the choice of clays:—The Tamworth clay is well represented by the Natural History Museum; the Ruabon by the Constitutional Club. Neither of these clays will vegetate, if properly burnt, and they are said to make harder wares than any other clays known. The wares have remarkably smooth surfaces and a close texture, giving out a clear metallic ring. All clays should be weathered, or exposed for some time before use; for it is generally found, when working a new bed of marl, that the shrinkage is great and uncertain. Nevertheless, a vast amount of good work has been turned out from clay that has not been weathered; but it is only with the very superior clays that this can be attempted with impunity. The term *marl* is used so vaguely as often to make its meaning ambiguous. In the brick-making districts of the southern and eastern counties, all clays containing much calcareous matter, whether naturally or artificially, are called marls (malms). All such are excluded from the marls proper for the manufacture of terra-cotta.

Journal of the Society of Arts.

No. 2,031. VOL. XXXIX.

FRIDAY, OCTOBER 23, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

A meeting of the Royal Commission was held on Wednesday afternoon, 21st inst., to receive the report of Mr. James Dredge and Sir Henry Trueman Wood on the result of their visit to Chicago. Present: The Attorney-General, M.P., in the chair; Sir Frederick Abel, K.C.B., F.R.S.; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.; Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Michael Carteighe; Lord Alfred S. Churchill; Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E.; Major-General J. F. D. Donnelly, C.B.; James Dredge; Francis Elgar, LL.D.; Sir Douglas Galton, K.C.B., D.C.L., F.R.S.; C. M. Kennedy, C.B.; John Biddulph Martin; George Matthey, F.R.S.; Wyndham S. Portal; W. H. Preece, F.R.S.; Sir Owen Roberts, M.A., F.S.A.; Prof. W. C. Roberts-Austen, C.B., F.R.S.; with Sir Henry Trueman Wood, Secretary.

The Report was received, and ordered to be printed, thanks having been voted to the authors. The Commission considered and approved a form of circular to Exhibitors, which was ordered to be issued. They decided to appoint the following Committees—Finance, Fine Arts, Indian, Colonial, Engineering, General Manufactures, Electricity, Agriculture, Mines and Metallurgy, Textile Industries, Science and Education, Transportation; also a Committee of Ladies to correspond with the Ladies' Committee at Chicago. They further decided to invite the assistance of Chambers of Commerce as Local Committees.

REPORT ON A VISIT MADE IN SEPTEMBER, 1891.

BY JAMES DREDGE AND SIR HENRY TRUEMAN WOOD.

We have now to report, for the information of the Royal Commission, the result of the inquiries made during the visit which we paid to Chicago in accordance with the instructions received from the Commission at their meeting of the 3rd September last:—

We started from Southampton on the 5th of September in the *Augusta-Victoria* (Hamburg-American line), as we were unable to obtain accommodation on any of the Liverpool Liners. By taking this course we had the advantage of accompanying back to the United States the members of the American Commission to Europe, the Hon. Benjamin Butterworth, Judge William Lindsay, the Hon. A. G. Bullock, Mr. F. W. Peck, and Major Moses P. Handy. In addition to this, we were fortunate in finding on board the Imperial Commissioner for Germany, Herr Wermuth. We were able to establish most cordial and friendly relations with this gentleman, and during the voyage we succeeded in formulating and obtaining his adhesion to a number of suggestions, embodying the principal points on which we required information, and the more important inquiries which we were instructed by the Commission to make. These propositions will be found in Appendix I.

On our arrival at New York, on September 12th, we were met by Mr. McCormick, the resident American Commissioner for Great Britain, who had come expressly from Chicago for the purpose. The first visit paid was to Mr. W. L. Booker, H. M. Consul-General at New York, and from him we learnt that the British Minister with all the members of the Legation was at Newport, so that it was not possible for us to present our credentials to him immediately on arrival, as had been our intention. It will be seen, however, that we were able to make an opportunity for doing so before leaving the country. On Monday, the 14th, we proceeded to Washington in a special car, which had most courteously been placed at our disposal by the Pennsylvania Railroad Company. We spent two days in Washington, the 15th and 16th, and this time was devoted to making the acquaintance of those members of the Cabinet who were in Washington, and the heads of the several Departments of State. Amongst those gentlemen may be mentioned

the Acting Secretary of State, Mr. Wharton; the Secretary of the Treasury, Mr. Foster; the Secretary for War, Mr. Proctor; the Secretary of the Navy, Mr. Tracy; the Secretary of the Interior, Mr. Noble; the Secretary for Agriculture, Mr. Rusk; the Postmaster-General, Mr. Wanamaker; the Attorney-General, Mr. Miller; the Commissioner for Patents, Mr. Simonds.

On the 16th we had the honour of an interview with the President, who expressed in warm and gratifying terms his appreciation of the prompt recognition of the Exhibition by Her Majesty's Government. On the same day we had an important interview with Mr. Foster, the Secretary of the Treasury, on the subject of the Customs requirements for the admission of foreign exhibitors' goods. The result of this interview was that considerable modifications have been made in the regulations which had previously been issued. The new regulations, which we think will, on the whole, be found satisfactory, will be issued immediately.

We left Washington on the 17th for Chicago, in company with Mr. Butterworth, Mr. Handy, and other members of the Exhibition Executive, and on this journey, again, we were made the subjects of the kind attention of one of the great railway companies of the country, for the President of the Baltimore and Ohio Railroad courteously placed his private car at our disposal for the journey to Chicago. At the last station before arriving at Chicago, we were met by a deputation, including the President of the Board of Directors, Mr. William T. Baker; Mr. Bryan, one of the Vice-Presidents; Colonel Davis, the Director-General of the Exhibition; and Messrs. Kohlsaat, Wacker, Waller, Peck, and Scott, Directors of the Exhibition. Shortly after arriving at our hotel, we received a call from Colonel Sadler, H.M. Consul at Chicago, a gentlemen whose kind attentions during our visit we desire cordially to acknowledge.

At Chicago the memorandum we had prepared was submitted to the principal members of the Exhibition Executive, and we were thus enabled to ascertain who were the proper authorities to decide the various points. The government of the Exhibition is of a dual nature. There are, in effect, two governing bodies—the National Commission, of which the Director-General, Colonel Davis, is the executive officer, and the Board of Directors, of which Mr. Baker is the president, and Mr. Butterworth is the secretary. The former

body is appointed by Congress, and is made up of representatives from all the States of the Union. The latter is elected by the stockholders who subscribed the funds. The distribution of space rests with the National Commission. Most of the other points raised in our memorandum were dealt with by committees of the Board of Directors.

We were invited to meet the Committees on (1) Ways and Means, (2) Grounds and Buildings, (3) Transportation. After discussing very fully the points in question, the several committees passed a series of resolutions, to which reference is made below, and of which copies will be found in the Appendixes.

We also had frequent opportunities of informal and individual conferences with the Director-General, the President of the Executive Committee, many of the Directors, and the chiefs of the various departments. To all these gentlemen our most cordial thanks are due for the courteous way in which they devoted their time and their attention to us, placing at our disposal the entire resources of the executive, affording us every facility for acquiring all the information we desired, and thus enabling us to complete our task in a much shorter time than would have been possible without such generous help.

We also desire to be permitted to place on record our appreciation of the kindly and lavish hospitality with which we were treated during the whole time of our stay in Chicago. This culminated in a public banquet given to the Commissioners to Europe and to ourselves on Tuesday, the 29th September, the day preceding our departure, at which about 250 persons were present.

We now proceed to give a brief summary of our proceedings day by day:—

On the 19th of September we were taken over the Exhibition Offices, and made a careful inspection of the plans of the buildings and grounds, we were also introduced to many of the principal officials connected with the Exhibition. In the afternoon of the same day we went by water to Jackson-park, the site of the Exhibition, and made a preliminary inspection of the locality.

On Monday, the 21st, we had a long interview with the Transportation Committee, and discussed with them the arrangements made for the conveyance of goods from the ports of arrival to the Exhibition grounds, and also the arrangements which it is proposed to make for the storage of exhibitors' empty packing cases. In regard to the transport question, it is proposed

to charge ordinary rates (which, it should be remarked, are very low) from the port of entry to Chicago, and to bring back the goods free of charge. We urged on the committee to use their influence with the railway companies to induce them to charge half-rates both ways. We have reason to hope that this, or some similar reduction, may finally be arranged. Included in the railroad charges, there is a small terminal charge, to cover the handling of the goods, their delivery on to the spaces assigned to them in the Exhibition, and their removal at the close. The charge of transport from steamer to rail is included in the amount. These charges, in the aggregate, amount to from half a cent to one and a half cents per ton per mile, according to the class of goods.

We discussed at considerable length the arrangements for the empty cases. At present, the Exhibition Executive propose to arrange for the storage of all cases, making a charge of two cents per cubic foot, or two and a half cents with insurance.

We explained to them the difficulties which had been experienced in former Exhibitions in dealing with this question, and, so far as foreign sections are concerned, recommended them to leave the matter in the hands of each of the Foreign Commissioners, giving them suitable accommodation for the storage.

We found the committee most anxious to meet our wishes in every way, but the final decision on this point was not arrived at. At all events, it may be taken for certain that the arrangements for the storage of cases will be at least as well carried out as in previous Exhibitions. Full details of the resolutions of the Transportation Committee on these subjects, as they stand at present, are embodied in Appendix II.

We were also favoured with an interview with Mrs. Potter Palmer, and some other members of the Ladies' Committee, who are interested in making a great exhibition of women's work, which is to form a prominent feature of the Exhibition. A separate building is being erected for this purpose, which is the work of a lady architect, and in this it is proposed to show the results of women's work in all countries. It is not intended to exclude the work of women from the general Exhibition, and work, whether in the Fine Arts or in any other department, which is intended to be submitted to the jury, will be included in the general sections; but it is the object of the Women's Committee to get specimens of

every class of work executed by women. They are especially anxious that a committee of ladies should be appointed in each of the contributing countries, and we undertook to submit their proposals to the Royal Commission. We suggest that such a committee might very well be formed, and a lady secretary appointed, and that they should be put in direct communication with the Ladies' Committee at Chicago.

On the afternoon of the same day, we met the Grounds and Buildings Committee, and discussed with them those points of our programme which came within their purview. The first of these was the site for the offices of the Royal Commission. They had reserved for Great Britain one of the most prominent and best sites in the grounds, with the idea that in all probability it would be the desire of the Royal Commission to erect on it a suitable building for their headquarters. The site is marked on a plan which is appended to this report (see p. 897). It is on the shore of the lake, closely adjacent to the United States Government Exhibits. We recommend that the Commission should take into consideration the erection thereon of a characteristic and handsome building, and feeling that this course would probably be adopted, we felt ourselves authorised to accept the site provisionally pending the approval of our action by the Commission.

The next point taken up was the condition in which the Courts will be handed over to foreign commissioners, and we received satisfactory assurances that they would be complete in every respect, only requiring such amount of decoration as might be necessary in order to give a special and national character to the spaces allotted to Great Britain.

We next submitted to the committee several requests for special concessions which had been sent in to the Secretary before our leaving Europe.

These requests were all granted, subject to arrangements, to be made with the Ways and Means Committee, as to the terms on which the concessions could be given in those cases in which the exhibitors proposed to sell refreshments, &c.

On the afternoon of the 22nd we attended a meeting of the Ways and Means Committee, and agreed with them that concessions for these and any future similar applications would be granted on reasonable terms. The precise rates could not be fixed, but it was agreed that in the case of these and

any future applications of this sort, proper particulars should be furnished to the committee, and they would then consider each case on its own individual merits. We are assured that the charges made will be most moderate in character, the object of the Executive not being to derive any considerable revenue from such sources as this, but merely to enforce proper restrictions on the sale of goods within the Exhibition.

The other points taken up with this committee were as follows :—

Sale of Goods.—We were informed that the sale of goods for immediate delivery in the Exhibition would not be permitted, but that it was in contemplation to erect a Bazaar of All Nations within the Exhibition grounds for the sale of small articles of local manufacture, the sales being strictly confined to articles of such character, and no general selling being allowed in this or any other portion of the Exhibition or grounds. The only exception to this rule is to be in the case of articles produced as illustrations of working processes. Samples will of course be allowed to be given away freely, and in addition the committee are quite prepared to give concessions, on almost nominal terms, for the sale of such articles. In these cases they desire to consider each case on its own individual merits.

Sale of Liquors.—Exhibitors of alcoholic or other beverages will not be allowed to sell the same, but facilities will be afforded for the sale of such beverages at the restaurants, and, where necessary, special concessions will be given for the sale of national beverages.

Restaurants.—We were informed that the Executive were anxious to receive offers from foreign refreshment contractors, and that they will be glad to have the assistance of the Foreign Commissions on this point. They have decided that they will not accept an offer from any foreign refreshment contractor, unless such an offer receives the endorsement of the Commission of the country to which it belongs.

Auxiliary Entertainments.—The Executive will be glad to receive any assistance the Commission can render them, in the way of advising them with respect to any auxiliary entertainments coming from Great Britain. It proposes to grant concessions for panoramas, theatrical performances, musical performances, &c. It is intended to allow proprietors of such shows to make a charge for admission, the amount of such charge to be approved by the Committee on Ways and Means, and to

levy a tax which may probably be from 25 to 35 per cent. of the gross takings.

At subsequent meetings of the two committees last mentioned, definite resolutions were passed, embodying the concessions made to us. These will be found in Appendixes III. and IV.

In the morning of the 22nd we were taken over Jackson-park, and made a careful inspection of the grounds and buildings which are in progress. We have made a special report on the grounds, which, as it appears too long for insertion in this place, has been made the subject of an Appendix. (See Appendix VI.)

On Wednesday, the 23rd, we went fully into the question of allotment of space. This was a matter which we had already discussed at considerable length with Mr. Davis, the Director-General; and he was in possession of our views on the subject. But on this occasion we had an opportunity of meeting him and the chiefs of the different departments, and going thoroughly into the question with them.

The original proposition was to classify all the exhibits entirely by subjects, without any regard to nationalities, and to locate the exhibits of each country, not only within the building to which they would properly belong, but also to subdivide them among the different classes. This minute subdivision was, however, long since abandoned; and the proposition which the Executive had in their minds was to allot a certain space in each building to each country, and to place in it all the exhibits belonging to that section from the country. That is to say, to place in the Electrical Building all electrical exhibits; in the Transportation Building, all exhibits having any connection with transportation, &c. We pointed out the difficulties which foreign sections would have in complying with this arrangement, and strongly urged upon the Director-General, in whose hands the question of the distribution of space lies, the necessity for allowing each country to collect its general exhibits, as far as possible, into a single court.

Our request in the first instance was, therefore, that space might be allotted us in the Fine Art Building, in the Industrial Building, in the Machinery Building, and in the Electrical Building, and that we should be allowed to put all exhibits, except pictures, and machinery in motion, into the space to be given to us in the Industrial Building. Our suggestion met with full consideration, and it was agreed that

we should be allowed to put the main bulk of our exhibits into the Industrial Building, whatever might be their character, with the understanding that if we find it possible to make a creditable representation in any of the other buildings, we should do so. To enable us to carry out this proposal the Director-General undertook to allot the space we had asked for in the Industrial Building, and to reserve for us spaces in the Agricultural, Transportation, and Mining Buildings, with the understanding that we should utilise this or not, as might prove desirable. The conclusions ultimately arrived at are embodied in a letter from the Director-General to the Secretary, given as Appendix V.

Stress was also laid upon the fact that it is desired to have not only commercial exhibits, but collections of a purely scientific character. Thus, for the Ethnological Department, exhibits relating to mankind in all countries and anthropological apparatus are desired; for the Department for Mines and Metallurgy, collections illustrating the mining and metallurgical interests of the various lands; for the Transportation Department vehicles of historical interest, early locomotives, &c. We promised that the Commission would use its utmost endeavours to secure this class of exhibits, and if they are successful in doing so, we would suggest that they may very well be exhibited along with similar collections of the United States and other countries.

The head of the Department of Mines and Mining made most liberal offers as to the conditions under which he would afford space for such collections, and promised that all the necessary fittings and the necessary attendance would be furnished gratuitously.

Among other points to which our attention was directed should be mentioned the Congress organisation, and the Jury arrangements.

Under the title of the World's Congress Auxiliary, an organisation has been attached to the Exhibition management, having for its object the direction of the various Congresses to be held at Chicago in 1893. The programme is a very extended one, and the congress work commencing in May, will continue till November. It is the intention of the citizens of Chicago to erect a large permanent building on the Lake front, and near the centre of the city; the ultimate purpose of this building is that of an Art Museum, but during 1893 it will be made use of for congress work, the Exhibition Executive pay-

ing a part of the cost in return for the privilege. If this building should not be large enough, overflow meetings will be held in the Auditorium Theatre, which will, on an emergency, contain 10,000 persons. The detailed plans concerning these congresses are at present incomplete, but they will doubtless prove of considerable importance and interest, and probably many distinguished persons in this country may desire to take part in them.

The organisation of the Juries, and the mode in which their labours shall be conducted, will be determined in all details by the National Commission. At present only general principles have been determined upon, and even these may yet be made the subject of modification. It is not intended that any money prizes shall be awarded to exhibitors, excepting those of live stock; these prizes will consist partly or wholly of money, the intention being to assist in some degree towards defraying the expenses of the prize winners. It is intended (though we are not aware how far these proposals have definitely been approved) that every exhibitor shall receive some souvenir of participation, irrespective of the merit of his exhibit. The juries will not be called on to make any recommendations of awards, nor will awards representing different grades of merit be made. The functions of the various juries will be to examine carefully all exhibits coming within their respective groups, and to select such as they find present a marked improvement over others. On such exhibits it will be the duty of the juries to make careful analytical reports, in which the special points of excellence will be clearly set forth. These reports, which will afterwards be collected and printed, will form an official Exhibition Record, and those exhibitors who are referred to will be at liberty to make public use of the testimony of the juries for their commercial benefit.

Of course it is clear that this method of procedure cannot apply to the art section of the Exhibition precisely as it does to mechanical and industrial sections, but the method to be followed has not yet been decided on. The whole question is, as above stated, an open one, but we have placed on record the information given us on the subject at Washington. It is certain that the juries will be international in all groups containing foreign exhibitors, and the composition of the juries will represent, as nearly as possible, international proportions of the groups.

The remainder of our time in Chicago was spent in discussing, either separately or to-

gether, the various points of detail with the members of the principal committees and the chiefs of departments.

From what we have said, it will be seen that all our requests were practically complied with, and we consider that we have been able to make the most satisfactory arrangements that could be desired for the reception of British exhibitors. We have been very much impressed with the manner in which this important work has been undertaken, and we have no doubt whatever of its ultimate success. It is also satisfactory to us to be able to state what we believe to be the truth, that our visit to Chicago has been of some little assistance to the Executive, and we felt it our duty to place any information which the experience of former exhibitions had given us, fully and unreservedly at their disposal.

On Wednesday, the 30th, we left Chicago for Philadelphia (being again provided with free travel by the Pennsylvania Railroad), and there we met Captain Clipperton, H.M. Consul at that city. On the following day we went on to Washington, and paid our respects to Sir Julian Pauncefoot, the British Minister. Sir Julian received us with much kindness, and undertook to promote the interests of the Exhibition by such means as came within his powers. We also had a second interview with Mr. Foster, the Secretary of the Treasury. In the evening of the 3rd October we were entertained by the Commissioners of the World's Columbian Commission from the District of Columbia at a dinner, at which were also present several members of the Cabinet and other distinguished citizens of Washington.

We arrived at New York on Monday, the 5th, and sailed for Europe on the 7th.

APPENDIX I.

MEMORANDUM ON INFORMATION DESIRED FOR THE ROYAL COMMISSION.

1. *Space Required.*—In the best judgment of the British and German Commissioners the amount of floor space required in various buildings to accommodate the various exhibits severally, from Germany and from Great Britain and Ireland and the British Colonies (so far as can be computed from inquiry and experience) will be approximately as follows:

In Machinery Hall	40,000 square feet.
In Electricity Building	20,000 „
In Industrial Building	120,000 „
In Fine Arts Building	20,000 „
Total	200,000 „

In the grounds a space of from 100,000 to 150,000

square feet will be probably required for the erection of Commissioners' headquarters and for various other pavilions.

2. *Arrangement of Exhibits.*—While—so far as the various classes are represented in the foreign sections—the official classification should be strictly adhered to, it will be possible only to arrange for the distribution of such foreign exhibits in the Fine Arts, General, Electrical and Mining Machinery, and Industrial Courts. The latter, which will constitute the most important courts of the German and British Commissioners, must contain within their limits the industrial and miscellaneous exhibits, which can be classified in accordance with the general scheme.

3. *Goods Sold in Exhibition Building for Immediate Delivery.*—Where such sales are permitted, it would be satisfactory to the Commissioners if all goods exposed for sale should, previous to exposure, be rated by the Customs authorities, and all dues paid by exhibitor.

4. *Goods Sold for Delivery after the close of Exhibition.*—Exhibitors of such goods should, in all cases, be at liberty to mark them for sale at such prices as they may think fit, entirely irrespective of all Customs' dues, such dues being paid to the Treasury Agents by the purchaser, prior to his removing the goods he has bought, after the close of the Exhibition.

5. *Despatch of Goods from Place of Manufacture.*—It is very essential to take such steps as will relieve the foreign exhibitor from a part or the whole of the regulations and official fees now in force, where goods are forwarded from abroad to the United States. In the ordinary course, declarations have to be made, forms lodged, and fees paid to the United States Consul. These restrictions, however necessary in the ordinary transmission of goods, will, if not relaxed, tend to discourage possible exhibitors. It is suggested that the official labels supplied to exhibitors by their respective Commissioners, and attached conspicuously on each case, addressed for delivery in the Exhibition Building, should be a sufficient guarantee. Cases properly addressed on their arrival in New York, would probably be taken in charge by the Customs officials, who would affix their seals to the cars conveying such goods to Jackson-park, where the seals would be removed by the proper officials.

6. *Transportation.*—It is earnestly requested that an early opportunity may be afforded the Commissioners of meeting the Transportation Committee, and that they may be informed of the arrangements that have been made for the transport of exhibitors' cases between the port of arrival and Chicago; of the scales of rates decided on, and of the probable reduction in passenger rates for exhibitors and their employes.

7. *Exhibitors of Processes for Producing Certain Articles of Consumption.*—Under what conditions will exhibitors be admitted, who show in constant process of manufacture, goods for consumption, and so are subject—in a degree—to the refreshment

regulations, but who in addition have an interesting and instructive exhibit, which can only be of interest by virtue of its producing articles of consumption commanding a ready sale on the grounds. Of this nature are Dairy exhibits, Tea-growing Companies, Bakeries, Ice-making Machines, Ice Cream-making Machines, plant for making Confectionery, Soap, &c. How far, and under what condition will such exhibitors be permitted to manufacture and sell their products? The Commissioners are prepared to bring forward typical cases for discussion.

8. *Sale of Liquors*.—Under what conditions will alcoholic liquors be admitted as exhibits; may samples be gratuitously distributed, or under what conditions may such samples be sold?

9. *Restaurant Concessions*.—It is desired to have the detailed conditions of concessions to be granted for foreign restaurants, and to know what specially favourable conditions will be included in such concessions for the sale of national beverages. It is assumed that no offer from any foreign refreshment contractor will be accepted, unless such offer is endorsed by the Commissioner of the country to which the contractor belongs.

10. *Condition of Courts*.—It is assumed that the various areas or courts allotted in the buildings to Foreign Commissioners will be delivered in such a condition as to be complete and ready for exhibitors in all respects, and that any constructive and decorative work will be wholly optional. The exact condition in which the Fine Art Courts will be delivered to Commissioners should be stated.

11. *Guardianship, &c.*—Detailed regulations are desired concerning guardianship of courts. To what extent does the Executive take on itself the task of guarding the various courts against robbery, fire, &c. And how far, and in what manner is co-operation in this respect possible between the Executive and the various Commissioners?

12. *Auxiliary Entertainments*.—It is evident that a certain number of foreign auxiliary entertainments may be expected, which will be of sufficient interest and importance for foreign Commissioners to endorse, and for the Executive to allot space and grant the necessary licenses. This has been done to a large extent, and with much success, at previous Exhibitions. It is necessary to know whether such auxiliary entertainments—as, for example, Panoramas, Theatrical, or Musical Performances, &c.—will be sanctioned, and under what conditions the Executive proposes to allow the proprietors of such shows to take money for admission, and otherwise reimburse themselves for their outlay. It is probable that the various Foreign Commissioners may be of service to the Executive from time to time, by bringing to their notice special transient theatrical and other entertainments, the proprietors of which may be desirous of visiting Chicago, in 1893, in connection with the Exhibition, and which would, in the judgment of the Commissioners, be beneficial to the welfare of the Exhibition.

13. *Congresses*.—It is suggested that an opportunity be afforded the Commissioners of meeting the World's Auxiliary Committee, with the view of obtaining information and expressing opinions on the subject of the General Conference. The same remark applies to the Women's Committee of the Exhibition.

14. *Machinery-hall*.—The Commissioners hope that the following information may be supplied at as early a date as possible. Plans showing foundations; arrangement of steam mains; water, condensed steam, and other waste mains; shafting; approximate amount of power to be furnished gratuitously, and the rates at which power will be supplied beyond the limit; position of hydrants; nature and head of water supply.

15. *Night Opening and Sunday Opening*.—Information is desired in detail, of the system under which the Exhibition will be partly or wholly opened in the evening or on Sundays.

16. *Catalogues*.—Full information is desired as to the conditions under which foreign Commissioners will be allowed to publish and sell catalogues or other official information relating to their respective sections.

17. *Miscellaneous Points*.—Information of a detailed and official character is requested on the following points:—(a) In what manner does the Executive propose to deal with empty cases. Will the Executive be prepared to allot suitable accommodation on the ground for the storage of such cases? (b) Juries and Awards: In the case of collective exhibits, will awards be made to such exhibits as a whole, or will each exhibitor contributing to the collection be treated as an individual exhibitor? Unless this be done, collective exhibits, which are most desirable from effective and instructive standpoints, would be somewhat difficult to organise. (c) Exhibition of live stock, cattle, fruit, vegetable, and other temporary shows. (d) Any general insurance scheme that may be elaborated. (e) The probable cost and supply of skilled and unskilled labour, and the cost of living in Chicago in 1893. This would be useful to refute the rumours about extravagant charges circulated in Europe.

18. *Suppression of Frauds on Foreign Exhibitors*.—It is almost needless to point out to the Executive that various unscrupulous persons are already practising on the credulity of possible foreign exhibitors, by representing themselves as being duly authorised to receive applications for space, and to take money for imaginary services. It is hoped that the Executive will do all in its power to suppress these practices, and to make it widely known that intending exhibitors of different countries must act solely through their respective Commissioners.

APPENDIX II.

TRANSPORTATION RATES ON EUROPEAN EXHIBITS.

Schedule of rates governing the transportation of exhibits from the principal seaboard ports to Chicago,

in cents per 100 pounds, which rates cover the placing of exhibits on or adjacent to the space allotted.

Schedule.

From	1st Class.	2nd Class.	3rd Class.	4th Class.	5th Class.	6th Class.
New York	83	73	58	43	38	33
Philadelphia	77	67	56	41	36	31
Baltimore	73	65	65	40	35	30
Boston	83	73	58	43	38	33
Portland, Me.. ..	73	65	52	36	34	30
Newport News ..	67	59	51	37	33	28
Montreal.. ..	73	65	52	39	34	30

From the above it will be seen that freight rates from New York to Chicago, *including switching and terminal charges*, as specified above, vary from half a cent. to one and one half cents per ton per mile.

When property is shipped on a through bill of lading to and from Chicago, there will be no charge for transfer from steamer to rail at the seaboard.

The class of rates herein quoted will, it is believed, cover such exhibits as are not of a particularly high grade.

Exceptionally fine goods, such as statuary, paintings, and fragile articles, which are classified from 1½ to double first-class, are charged at proportionately higher rates than those scheduled. The arrangements thus far made with the transportation lines are, that tariff rates shall be collected on forward journey according to official classification attached hereto. Exhibits will be returned free (with the exception of a charge of eight cents per 100 pounds for switching and handling from grounds to junction or intersecting points of railroads centering in Chicago) to the seaboard port from which they were shipped on forward journey, and over the same routes first used. This arrangement applies to all exhibits except horses and other fancy animals, on which tariff rates will be charged in both directions, the rules in classification to apply which permit the free carriage of one attendant in charge of animals.

The words "and other fancy animals" do not apply to cattle, hogs, and sheep. This class of live stock is returned free (excepting the switching charge above noted) the same as other exhibits.

Freight charges on exhibits must be prepaid at the point of shipment, the goods being delivered at the Exposition clear of all charges incident to their transportation.

STORAGE RATES FOR EMPTY CASES.

The charge for removing, storing, and returning empty cases and packing material for exhibitors who request it, will be as follows:—

For empty cases and packing material without insurance two (2) cents per cubic foot.

For empty packing-cases and packing material, with insurance, two and one-half (2½) cents per cubic foot.

The following statement, reproduced for comparative purposes, shows the cost of similar service at other Expositions:—

	Per Cubic Feet.
London..... 1862	\$.059
Vienna..... 1873 .....	.02
Philadelphia . 1876 (without insurance)	.018
Paris..... 1889 (" ")	.029
Paris..... 1889 (including insurance)	.162

The above is an official copy of the rates approved by the Committee on Transportation, September 28th, 1891.

ELBERT E. JAYCOX,
Traffic Manager.

APPENDIX III.

Committee on Grounds and Buildings, of the
World's Columbian Exposition, Chicago,
Sept. 26th, 1891.

Sir Henry Trueman Wood, Secretary. Royal Commission for England.

DEAR SIR,—I have the honour to transmit herewith copy of memoranda, relative to the exhibits of Great Britain at the World's Columbian Exposition. Said memoranda were adopted by the Committee on Grounds and Buildings at its meeting of the 25th inst.

Very respectfully,

(Signed) A. W. SAWYER,
Secretary.

Committee on Grounds and Buildings of the
World's Columbian Exposition, Chicago,
Sept. 26th, 1891.

I hereby certify that the attached is a true and correct copy of memoranda adopted by the Committee on Grounds and Buildings, at a meeting held on the 25th inst., relative to the British exhibits.

(Signed) A. W. SAWYER,
Secretary.

APPROVED :

(Signed) GEO. R. DAVIS,
Director-General.

GROUND'S AND BUILDINGS.

It is agreed that the location shown on the accompanying plan of the Construction Department is set apart for the building to be erected by the British Commission for their head-quarters. The plans for said building to be approved by the Chief of Construction.

* * * * *

While it is impossible at this time to designate exact locations for the above-mentioned concessions and privileges, yet it will be the aim of this Com-

mittee to locate them as favourably as possible, having in view the uses to which they will be put.

Any similar concessions recommended by the Royal Commission will also be considered favourably on their merits.

The terms on which the above and future concessions will be granted to be determined by the Ways and Means Committee, the necessary particulars being supplied by the Commission.

It is expected that there will be concessions granted for English restaurants within the buildings, and also in the grounds.

It is understood and agreed that the buildings for each section will be delivered ready for exhibitors, including the general scheme of decoration, with sufficient water supply and sunshades where required.

The space in the Fine Art Building will be delivered to the Commission complete, and in readiness to hang pictures.

APPENDIX IV.

Ways and Means Committee of the World's
Columbian Exposition,
Rand McNally Buildings, Chicago,
September 28, 1891.

*Sir Henry Wood, Secretary of the Royal Commission
for England to the World's Columbian Exposition.*

DEAR SIR,—I have the honour to herewith enclose a certified copy of the regulations adopted by the Ways and Means Committee of the World's Columbian Exposition, at its regular session held Friday, September 25, 1891,

Yours respectfully,

(Signed) SAM. A. CRAWFORD,
Secretary.

REGULATIONS OF THE WAYS AND MEANS COMMITTEE.

For the information of the Commissioners, the Committee on Ways and Means hereby state that the sale of goods for immediate delivery and consumption will be prohibited in all the buildings except where concessions or privileges are specially given on the merits of the individual cases, but no concessions will be granted for general merchandising, either within the buildings or within the grounds of the Exposition.

It is intended to set aside a space for a Bazaar of all Nations, in which may be sold for immediate delivery and consumption, such articles as are unique and peculiar to the countries where they are produced, subject, however, in each case to the approval of the Committee of Ways and Means.

Articles manufactured in the Exposition as illustrations of processes may be sold, but the exhibitor will be required to obtain the privileges which will be granted or withheld at the discretion of the Ways and Means Committee.

It is understood and agreed that no alcoholic or other beverages shall be sold by exhibitors of such beverages, except in special cases where the proper concession has been granted. Samples of spirituous and malt liquors may be given away under restrictions to be prescribed hereafter.

The Commissioners are informed by the Committee of Ways and Means that, subject to the approval of the respective Commissions and the Committee on Ways and Means, space will be given and concessions granted for auxiliary entertainments, and that the terms upon which such concessions would be granted to each of these auxiliary entertainments would be decided upon the individual merits of the case, and that as a general principle a charge, varying from 25 to 33 per cent. of the gross receipts, will be made and collected as the price of the concession.

The Commissioners are informed that the question of a whole or partial opening at night would be reserved until later.

I hereby certify that the above is a true and correct copy of the regulations adopted by the Ways and Means Committee at its regulated Session, held Friday, September 25th, 1891.

(Signed) SAM. A. CRAWFORD,
Secretary.

APPENDIX V.

Office of the Director-General,
World's Columbian Exposition,
Chicago, Ill., U.S.A.,
Sept. 29, 1891.

*To the Secretary for the Royal Commission for Great
Britain at the World's Columbian Exposition.*

SIR,—In pursuance of, and in conformance with, interviews heretofore held concerning the installation of the exhibits at the World's Columbian Exposition of the Government of Great Britain, and the extent and method thereof, I have the honour to say:—

The Government of Great Britain having signified its willingness to participate in the World's Columbian Exposition, in illustrating the progress of education, science, art, and the industries, since the discovery it is intended to commemorate, and the Government of Great Britain having commissioned distinguished representatives to come to this city and arrange the details of its participation, it is becoming on the part of the management of the Columbian Exposition that a broad and liberal sentiment, cordial in its character and business-like in its application, should govern its policy in all transactions with your Government and its Commissioners.

The scope and classification provides for twelve great exposition departments, and, for their adequate and appropriate arrangement and display, nine great departmental buildings have been provided for, and are now in process of rapid construction.

It is the desire, of course, that your Honourable Commission instal in the spaces assigned to your Government in each of the said departmental buildings. But, in the event that your Honourable Commission deem it expedient so to do, the management of the Exposition begs to assure you that it will construe your objections and preferences with liberal and comprehensive consideration.

The assignment of space in each of the said Departmental buildings for the exhibits of the Government of Great Britain will be in one compact block or court. If, for any reason, the articles for exhibition may not be of such quantity, or in such condition as to justify their installation in the building where, by the classification, they would properly belong, the said article may, nevertheless, be installed in the space assigned your Government in any other building, and the said articles shall not thereby lose their place in the catalogue, nor be deprived of the right of competition.

I beg to suggest that the exhibits of articles of a certain group or groups provided for in separate departments may require such a quantity of space for arrangement and display as to make necessary their installation in the building or buildings provided for such exhibits by the classification, in which case the management do not wish to be understood as having surrendered their right to modify the general proposition above stated.

I have the honour to communicate that space for the installation of exhibits from the Government of Great Britain and all of her Colonies and Dependencies (the division of the same hereafter to be made, as your Honourable Commission have indicated that you are not authorised to apply for or accept space for all the Colonies) is assigned in the several buildings, in gross, as follows:—

	Square Feet.
The Manufacturing or Industrial Building (not including Canada) }	120,000
Machinery-hall	40,000
Electricity Building	20,000
Fine Arts-hall	20,000
Mines and Mining Building (including Canada)..... }	25,000
Agricultural Building (including Canada)	25,000

In addition to the foregoing, 15,000 square feet will be held in the Agricultural Building, until your Honourable Commission shall have decided where the exhibits of wine, beers, and canned fruits and vegetables shall be made. Space will also be reserved in the Horticultural-hall, Fish and Fisheries Building, and Transportation Building, until your Honourable Commission have had opportunity to ascertain if the same will be required.

I have the honour to be, &c.,

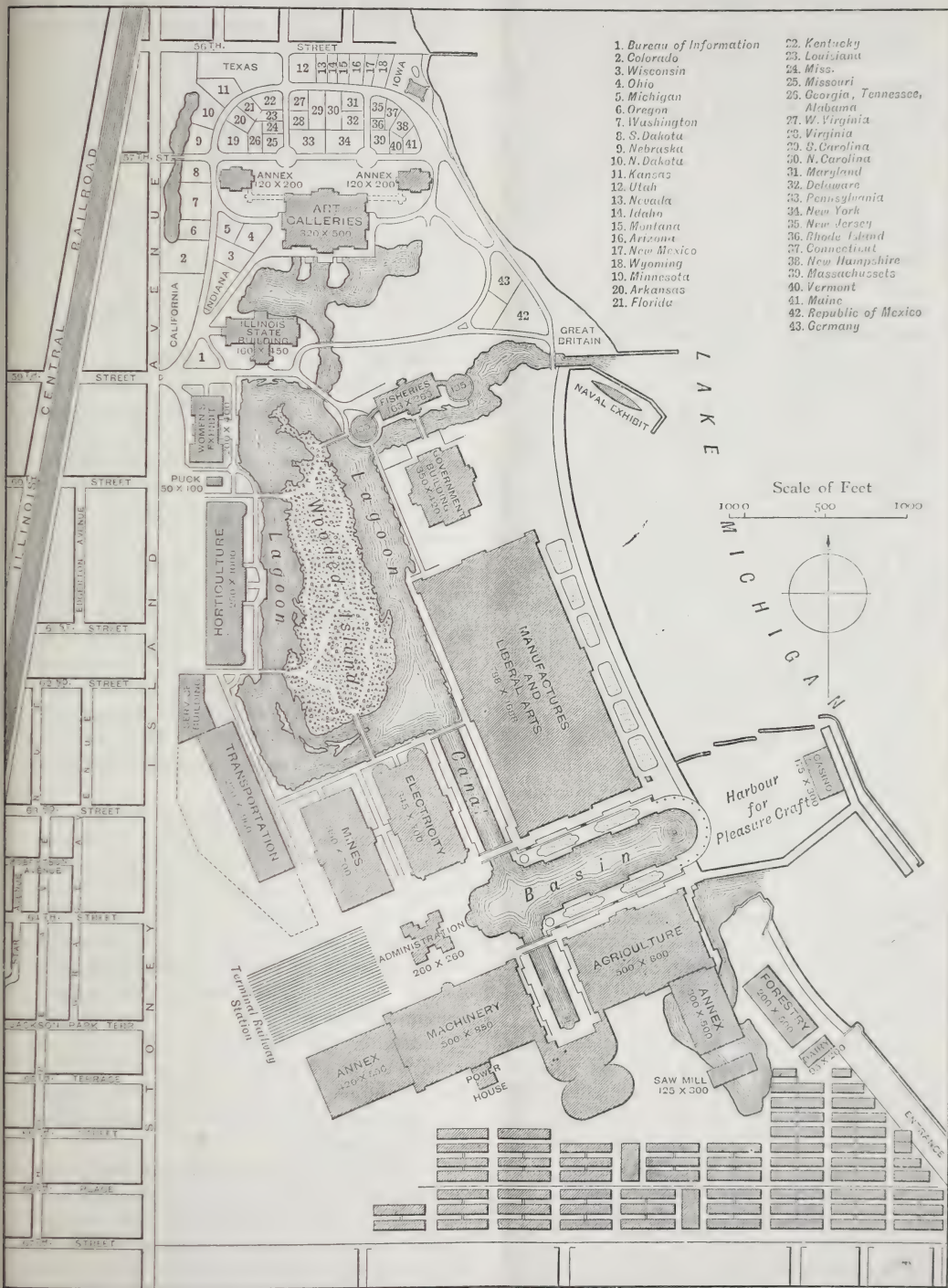
(Signed) GEO. R. DAVIS,
Director General.

APPENDIX VI.

SPECIAL REPORT ON THE GROUNDS AND BUILDINGS AT JACKSON-PARK, FOR THE WORLD'S COLUMBIAN EXHIBITION OF 1893.

Jackson-park, on which the Columbian Exhibition is located, has an area of about 800 acres; it is situated some six miles south of the centre of the city. Only a small part of this park had been reclaimed and laid out, so that the Exhibition Executive have had to deal mainly with waste land. As will be seen from the annexed plan, the park is bounded on the north by Fifty-sixth Street, on the south by Sixty-seventh Street, on the west by Stoney Island Avenue, and on the east by Lake Michigan. The presence of this vast sheet of water lends a peculiar charm to the site, and gives it a natural advantage which has not been enjoyed by any previous International Exhibition. The area is practically level, but the excavations on a part of the foreshore, and those of the landscape gardener, have furnished enough material to raise the ground, where necessary for producing a decorative effect, and the monotony of uniform level ground will be entirely avoided. The shape of the enclosure is approximately triangular, the base of the triangle being the southern boundary of Sixty-seventh Street; the lake shore curves back to the northern limit (Fifty-sixth Street), which is parallel to the southern, and only about 1,800 feet in length. The western boundary runs almost due north and south.

The great central feature of the Exhibition will be a grand avenue about 1 800 feet in length, extending westward from the lake, and at right angles to the shore. A pier 1,000 feet long, with a T-shaped head of similar length, forms an extension of the avenue. On the pier-head *cafés* will be erected, and the water area enclosed by the pier will form the exhibition space for small craft. In the middle of the grand avenue, and extending for its whole length, will be a great basin, direct communication being established between it and the lake, although the connection is dissimulated from above by a semicircular mole carried on wide arches, and enriched with thirteen columns, each supporting the device of one of the original thirteen States of the Union. At the inner or western end of the basin will be a monumental fountain, emblematic of the Republic. Near the same end of this basin, two canals are taken from it at right



PLAN OF JACKSON-PARK, SHEWING BUILDINGS FOR THE CHICAGO EXHIBITION, 1893.

angles. The southern branch is only of small extent, and terminates opposite a colonnade, to be referred to presently. The northern canal, after a short course between formal and parallel terraces, widens out into a lagoon of irregular form, occupying the central part of the grounds, and in this lagoon is a large and picturesque wooded island. Near the south end a sinuous outlet from the lagoon finds its way into the lake, and, quite at the northern extremity, another outlet widens into a small lake, between the Art Gallery and the Illinois State Building.

Returning to the basin from which this large water system will be supplied, it should be remarked that its sloping banks will be grassed and terraced, and that numerous landing stairs will be provided to accommodate the heavy traffic from the electric boats, which are to ply constantly. The highest terrace on each side of the basin will correspond with the floor level of the buildings. The most important of these are as follows:—On the north side, and facing the lake, is the building of Manufactures and Liberal Arts. This will be essentially the monumental structure at Jackson-park. It will be, approximately, 1,700 feet long and 800 feet wide, with a great hall more than 1,600 feet in length, and 368 feet wide. This will be covered by a roof of a single span, and 208 feet in height. The span is about the same as that of the Machinery-hall at the Paris Exhibition 1889, but the height is 61 feet greater. On each side of this vast enclosure will run covered galleries 205 feet wide, divided into a main arched roof of 107 feet span, and two narrow side spans. These latter will be broken by upper galleries, about 25 feet above the ground. As there will be more than a mile of these upper galleries in this building, the accommodation for exhibits will be largely increased by them.

The covered floor space of the building will be nearly 1,500,000 square feet; an area insufficient to meet the demands already made. It was the intention to devote considerable space at one end of this vast building to an anthropological collection. It is likely, however that this collection will be disposed in the galleries, which will be easily accessible by elevators and staircases.

The space allotted to Great Britain and the Colonies is to adjoin that of the United States, with a frontage on the great aisle running down the centre of the building, and including a length of the side galleries before re-

ferred to, and which will lend themselves for picturesque division into Courts.

The great girders of the main-roof will be placed 50 feet apart, and projecting galleries of that length, and about 25 feet from the floor will occupy the space between the girders at that level. These galleries, giving upon the great Central Hall, will not be used for exhibits, but will be reserved for the convenience of visitors.

A broad strip of ground lies between the eastern front of the Industrial Building, and the lake. This space will probably be occupied with high class restaurants.

On the western side of the building is the canal leading to the lagoon, and beyond it are the Electricity and Mines Buildings. The former of these covers an area of $4\frac{1}{2}$ acres, and consists of a great central hall surrounded by smaller galleries. In this building will be collected illustrations of all kinds of applied electrical science, excepting machinery for generating current for transmission. The motors shown will receive their current from the great power station in the machinery-hall, and they will be exhibited in motion doing useful work; the supplementary machines they operate will, however, be subordinated as much as possible in order that the special purpose of the building may not be thrown in the background. Historical collections, illustrating the growth of electrical science in its various branches, will form one of the principal attractions of this building.

The Mines and Metallurgy Building, like the one just referred to, will occupy an area of about $4\frac{1}{2}$ acres; its title sufficiently explains the purpose to which it will be devoted. What power may be required to set the machinery exhibited in motion, will be obtained from the current supplied by the Machinery-hall power station. To the student the most interesting contents of this building will be the mineral and metallurgical collections, which will be contributed from every State in the Union. The Exhibition authorities express the hope that European societies will also contribute mineral collections.

On the southern side of the basin, and near the lake, is the Agricultural Building, with a large annexe on the eastern side, and a Forestry Building close by. This Hall, which will be of very large dimensions, will adjoin the Stock-yard, where an enclosure of about 70 acres has been set aside, and will be fitted with all convenience (see plan) for the display of all kinds of live stock.

West of the short canal, by the Agricultural Building, is the Machinery-hall and its annexe. As will be seen from the plan, the Agricultural and Machinery-halls are connected above the head of the canal. This connection consists of an ornamental colonnade and court, which will be of high architectural and decorative value. The richly decorated architectural front of the Machinery-hall adjoins the great central avenue, but the building itself has no monumental constructive features, behind the façade. It is composed of a series of arched roofs of moderate span, but collectively enclosing a large area (500 feet by 850 feet). In each span, and for the length of the building, travelling platforms will be provided for convenience in erecting exhibits, in the first place, and for conveying visitors when the Exhibition is opened. The supports of the rails on which these platforms move will carry the shafting for transmitting power to machinery in motion. It is intended to have a power installation of 25,000 horse-power. The engines developing this will be placed together at one side of the Machinery-hall, and near the great boiler-house, in which all the steam required will be generated. The larger part of this power will be converted into electrical energy, so that this part of the Machinery-hall will be an electric power generating station on a very large scale.

Among other purposes, the current will be used for working an elevated electric railway that will make a circuit of the grounds. All the lighting—both arc and incandescence—in the grounds and buildings will be controlled from this station, and current will be supplied to the electricity and other buildings. It is intended that the motors exhibited in the Machinery-hall shall be driven by compressed air, instead of by steam; and, to effect this, a sufficient number of air compressors will be provided, and operated from the power station. If this arrangement be carried out, there will be only a very small steam distribution required for injecting with the compressed air into the cylinders of the motors, and what may be wanted for some miscellaneous purposes.

Boilers, engines, dynamos, air compressors, and other machinery forming this power station, will constitute exhibits; and manufacturers placing such exhibits at the service of the Exhibition will have certain advantages. Thus all foundations will be constructed. The erection of the engines, or other machines, will be carried out by the exhibitor at the cost of the Exhibition authorities, who will also pay

all charges connected with working the machines during the period of the Exhibition. A careful series of competitive trials with the engines, dynamos, &c., of the power station will also be made and recorded.

It may be mentioned here that the ground at Jackson-park is of a character to require a special class of foundations where great loads are to be carried. For the convenience of exhibitors of heavy machinery, the Construction Department has expressed its intention of preparing a set of type drawings of different kinds and sizes of foundations.

Occupying the centre of the large rectangle between the Machinery-hall, the Electricity and Mines Buildings, and the western end of the basin, will be the Administration Building, which will be an exhibit only so far as architectural design, engineering construction, and materials are concerned. Its main features will be a rotunda 160 feet diameter, rising from the mosaic floor to a height of about 250 feet. The dome covering this rotunda will be supported on an octagonal base, several storeys in height, which will contain the administration and other offices. It will be seen that this great building will close the perspective of the Grand-avenue, and form a fitting termination to the long lines of rich and classic façades on each side. It should be mentioned that the most elaborate architectural effect has been concentrated in this part of the Exhibition. The exteriors are the designs of various well-known architects in different parts of the United States; but certain restrictions were imposed, in order that the general effect of this vast street of palaces may be in harmony.

At the back of the Administration Building the position of the main terminal railroad station is shown; the arrangements to be adopted with regard to this station are not settled, but it is not probable that any alteration will be made in the site.

The wooded island in the lagoon, which will be one of the principal ornamental features of the ground, is already partially timbered, and its surface is accentuated enough to throw it into considerable relief. The work of planting the island with indigenous trees will be carried on until it becomes an exhibit of American forestry. No buildings will be allowed here, but the island will be accessible to the public. Around the lagoon are grouped several structures. On the western side and near the Mines Building, is the Transportation Building, measuring 250 feet by 960 feet. In this will be collected as many objects

as possible from the United States, relating to transportation of all kinds—land, water, and aerial. These exhibits will be classified according to their purposes and periods, so that it is intended that a history of all classes of transportation shall be obtained. As this will include examples of the most modern locomotives, models of ocean steamers, road vehicles, &c., it will be seen that the building will be filled somewhat at the expense of the machinery, agricultural, and some other Sections. It is hoped by the Exhibition Directors that foreign countries will allow their exhibits relating to transportation to be shown in this building, and space has been allotted to Great Britain and other nations with this intention. The arrangement of the contents of the building will be such that American as well as foreign exhibits may illustrate a continuous sequence of the various modes of transportation.

To the northward is the great Horticultural Palace, around and near which, sufficient space is left to allow for out-of-doors displays of plants and flowers. Little need be said about this building, except that it forms a conservatory on an enormous scale, measuring 250 feet by 1,000 feet, with a large and lofty central dome. Extensive as is the space enclosed by this glass and steel structure, it has already been applied for, and will prove quite insufficient for the horticulturists and floriculturists of the United States. Space has been reserved for the erection of many other smaller glass-houses, and chiefs of the floricultural department of the Exhibition anticipate that much support will be given them by British floriculturists, who have extensive business relations with the United States.

Still to the north is the Women's Building to which reference has already been made in the body of our report. This structure measures 200 feet by 400 feet, and is well advanced.

On the eastern side of the lagoon, between the northern end of the Industrial Building and the outlet from the lagoon to the lake, is a large space reserved for the National Government exhibits. A handsome structure facing the lake, and measuring 350 feet by 420 feet, will contain the contributions of the different Departments, excepting that of the Navy. The ground about this building will be devoted wholly to Government displays, which it is understood will be largely of a military character. In the lake, and protected by a breakwater, will be the very interesting exhibit

of the Navy Department. This exhibit will comprise, and be contained in, a full-sized model of a battle-ship, the original of which (the *Illinois*) is to form the most powerful addition to the United States fleet. This model, which is to be complete in all respect, to 2 or 3 feet below the water, is to be carried on a pile-supported platform. The materials used in its construction will be concrete, brickwork, timber, and iron, and the model will be completed as regards its armament and full equipment, in all details. In addition, room will be found for the numerous objects to be exhibited by the Navy Department.

To the north of the outlet from the lagoon to the lake is located the Fisheries Building, with annexes at each end containing aquaria. This building will be 363 feet long, 463 feet wide, and its contents will certainly be of great interest. We believe we are correct in saying that the official piscicultural display will be contained in the Government Buildings.

Between the inlet and the lake, in front of the Art Building, is a large open space, that has been reserved for the use of such foreign nations as desire to erect some characteristic structures for their administrative purposes. The point of land shown on the plan to the north of the model ship has been allotted to Great Britain; behind this is the Mexican allotment; and adjoining is the ground given to Germany for their special building. Up to the present time, no other allotments in this part of the ground have been made. This area, and all the remaining enclosure to the north, constitutes the portion of Jackson-park that had been completed, and the locations are consequently, of a very favourable character. It is also in the improved part of the park that the Art Building and its annexes will stand. The Art Building is purely classic in design, and not of large proportions, as it only contains four courts, of about 20,000 feet of floor space each. These courts are separated by two broad passages, at right angles to each other, and intersecting beneath a central dome, that forms the leading feature of the building. This rotunda and the central passages will be utilised for statuary.

One of the four courts above referred to will be occupied by the United States, and we understand that a similar court adjoining has been assigned to Great Britain. It is obvious that the building will not be large enough to receive all the art exhibits, and annexes, harmonising in design with the principal building, will be erected near it.

It should be mentioned that the Art Building and annexes are fireproof—that is, no timber is used in their construction—brick, steel, and terra-cotta being the materials chiefly employed. The system of enclosing the steel frame-work with hollow terra-cotta bricks and tiles, in such a way as to leave air spaces around the metal thus protected, is adopted in all permanent Chicago structures ; and it is this system that will be carried out in the Fine Art Buildings.

Finally, in the extreme north corner of the park will be grouped, in very close proximity, the buildings of the various States. As it is probable that not one of the forty-four States will be absent, and as a great diversity in size and design will characterise these buildings, there will be a total absence of harmony between them, an arrangement which, in its striking contrasts, will undoubtedly render this one of the most attractive portions of the Exhibition. Only the State of Illinois is privileged to stand apart from the others, and her very handsome building, placed between the lagoon and the lake, and almost opposite the Art Galleries, will be a conspicuous object in this part of the grounds.

It was originally supposed that Jackson-park would not be large enough for the Columbian Exhibition Buildings, and the right of occupying Washington-park was obtained. Events have proved that Jackson-park will be sufficiently spacious, and it is not probable that any portion of Washington-park will be drawn upon. The two parks are about a mile apart, and are connected by a straight road about 600 feet in width ; this connecting link is known as the Midway Plaisance, and one end of it is shown on the annexed plan, between Fifty-ninth and Sixtieth Streets. As will be seen, the tracks of the Illinois Central Railroad cross the Midway Plaisance on the level, and suitable bridges, with stairways and elevators, will be built over the railroad to secure public access to the Midway Plaisance, the whole length of which will be enclosed within the Exhibition fence. If the present scheme be carried out, this part of the grounds will be converted into a bazaar of all nations ; in one part the Turkish flag has been hoisted to mark the site of a future Rue de Caire ; a large space has been allotted to Germany for the reproduction of a German village ; and it is anticipated that, before long, the whole area will be taken up for entertainments, beer and other refreshment gardens, booths for the sale of goods, panoramas, &c. The allotment of

all, or nearly all, this space will form the subject of concessions.

A few words should be added on the present condition of the works at Jackson-park, and the character of the buildings to be erected there. The greater part of the preparatory work had been completed at the date of our visit ; clearing, excavation, dredging, &c. The pier was practically complete, and in constant use for the transhipment of timber and other materials from vessels to railway trucks. A very extensive system of contractors' railways had been spread over the grounds, and the laying of water mains was being rapidly pushed forward. A daily supply of 40 or 50 million gallons will be available for the needs of the Exhibition and for fire service. In addition to this, mineral spring water for drinking purposes is to be brought in mains from a distance of 90 miles. The framework of the Women's Building, and of the Transportation and Mining Buildings was well advanced, and the foundations of the Administration and several other important buildings were practically complete. The work on the Manufactures and Liberal Arts Hall was being pushed forward. Where it has been found necessary, piled foundations have been employed, but for the most part the characteristic platform foundations of Chicago are used, with this difference, that instead of steel beams timbers are substituted, as all the buildings are of a temporary nature.

It was originally intended to use wood for all buildings not of very large dimensions ; fortunately this intention has been changed and steel is to be used exclusively except for quite small roofs. Timber is employed almost universally for the substructure from the foundations to the roof, but it will to a large extent be concealed by decoration. So far as we could judge, great skill, as well as boldness, characterises the general engineering designs, which are all prepared in the Construction Department of which Mr. Burnham is the head. The architects who furnished designs for the various façades have little to do with the execution of their work, which is rendered in cement and plaster on timber framing ; the designs for this framing are very elaborate and are all prepared in the Construction Department. Gold and rich colour will be very liberally applied in the finished decorations, and it is gratifying to place on record the fact that this important work is controlled by an English artist, Mr. Prettyman.

Before leaving this part of the subject, we

may mention that the question of transporting passengers between the city and the Exhibition has already received much attention, and there is no doubt the problem will be successfully solved. The Illinois Central Railroad now runs from the city past the grounds with a number of tracks, and these can be increased as much as is necessary. Cable and horse street railways will have a larger capacity than at present, and a fleet of fast steamboats will be placed on the lake to run between the city and Jackson-park. There need be no apprehension about the efficiency of transport. Within the grounds the question of intra-mural railways is a very serious one. As already stated, an electric circuit railway will convey visitors to all the principal buildings; along the whole length of the Midway Plaisance a water sliding railway is to operate, and a variety of means for transporting large numbers of people will be made use of. On the water, electric omnibus boats will perform a rapid service, and a large number of small boats will be always available.

It will, however, be difficult for the authorities to provide too liberally for the easy circulation of visitors within the vast enclosure.

The *Philadelphia Public Ledger* recently gave a very full account of the Finances of the Exhibition, which is here extracted:—

The elaborate scale upon which the Fair is projected will require a large amount of money. The finances are based upon an original issue of £1,000,000 capital stock, all taken, and a recent second issue of equal amount partially subscribed. Three instalments of 20 per cent. each have been called, the last upon September 1st. At the latest report, September 19th, £1,105,100 of stock had been subscribed and £600,200 paid into the treasury. This sum is being steadily increased by additional payments. To further aid the enterprise the city of Chicago has issued £1,000,000 four per cent. 20 year municipal bonds available when £600,000 actual money was paid upon the stock. These bonds are expected to be soon placed upon the market and sold as money may be wanted. The plan will produce when all the stock now subscribed is fully paid (without additional subscriptions) £1,107,100 from shares and £1,000,000 from bonds. In addition the management expect to realise £100,000 from concessions and the sale of privileges, £200,000 from salvage, and about £400,000 from admissions, making a total of £4,120,000 available for the Fair. The estimated cost of buildings, grounds, and all prepara-

tions, down to the opening day, and all operating expenses afterwards, was reported, at a recent meeting of the Commission, at £3,525,100, leaving an apparent surplus income of £600,000. To get timely control of their resources the Commission expect to ask the approaching session of Congress to advance £1,000,000 as a Government loan, for which the admissions will be mortgaged and used in repayment. The National and State Governments are also providing large additional sums which will add to the attractions of the Fair. The United States has appropriated £300,000, and the State of Illinois £160,000. All the States together have thus far voted £537,000, with several yet to act. This makes a grant total of "money in sight" for the Fair of £4,956,000. Various sums are also provided by foreign nations for their special departments, as follows:—Great Britain, £25,000; France, £48,000 (asked); Germany, £4,000 voted, and £50,000 (asked); Japan, £100,000; Mexico, £150,000; Peru, £5,000; Costa Rica, £10,000; Colombia, £16,000; Guatemala, £24,000; Jamaica, £2,000; Chili, £20,000; Egypt, £1,000 preliminary, and £6,000 asked; Brazil, £65,000. An increased amount is expected from Mexico, and Russia is also expected to vote a liberal sum. The above estimate of expenses is generally regarded as an outside figure, for such favourable contracts have been made for the buildings now in course of construction that thus far the officials consider that, in their projected expenditure, they are actually within the estimates some £300,000. The actual disbursements made on account of all expenses of the Exhibition down to September 19th were £218,603; and, at that time, the Exhibition treasury held about £391,400, which was on deposit at interest in various Chicago banks, so that the present financial conditions (without yet realising at all upon a single one of the £1,000,000 of bonds) are decidedly easy. The treasury has already got £6,000 from interest on its deposits. A vigorous campaign is being conducted to get Western and Southern members of Congress to pledge support to the projected loan from the United States, and they express great confidence of success. Should the plan miscarry, however, then the Chicago banks and capitalists are said to be ready to advance the money as needed, so that the financial conditions of the Fair seem, from the present outlook, to be very good. One great advantage they have is, that the work is progressing decidedly within the estimates.

Forms of application for space, and prospectuses with detailed information, are now ready, and will be sent out in a few days. Prospectuses can be had on application to the Secretary of the Royal Commission, Society of Arts, John-street, Adelphi.

Journal of the Society of Arts.

No. 2,032. VOL. XXXIX.

FRIDAY, OCTOBER 30, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1892.

The subjects of examination are—1. Arithmetic; 2. English (including composition and correspondence, and précis writing); 3. Book-keeping; 4. Commercial Geography; 5. Shorthand; 6. Type-writing; 7. French; 8. German; 9. Italian; 10. Spanish; 11. Portuguese; 12. Russian; 13. Danish; 14. Chinese; 15. Japanese; 16. Political Economy; 17. Theory of Music; 18. Practice of Music.

The Society's Bronze Medals are offered in every subject, and in certain of the subjects Prizes are offered in addition.

These examinations will be held on April 4, 5, 6, and 7, with the exception of that in the Practice of Music, which will be held during the week commencing on the 31st of May.

In addition to the syllabus of examinations, the Programme contains an appendix giving the questions set in 1891, and the reports of the examiners on the papers worked.

The Programme is now ready. Copies can be obtained gratis on application to the Secretary.

SPECIAL EXAMINATION, SEPTEMBER, 1891.

The following is the result of the Examination, held by request of the School Board for London, of applicants for teacherships in its Evening Classes:—

Subjects.	No. Examined.	First Class.	Second Class.	Third Class.	Not Passed.
Book-keeping.....	321	8	108	148	57
Shorthand	40	—	1	15	24
French	62	4	8	33	17
Totals.....	423	12	117	196	98

UNION OF INSTITUTIONS.

The following institutions have been received into Union since the last announcement:—

North Eastern Railway Literary Institution, Gateshead.

Engineering School and Government School of Science and Art, Rochdale.

Chicago Exhibition, 1893.

Under date of the 27th August, 1891, Her Majesty was pleased to issue a Commission to the Council of the Society of Arts, authorising them to act as Commissioners for the Universal Exhibition, which, pursuant to an Act of Congress, and in accordance with a Proclamation made by the President of the United States of America, will be held at Chicago from May 1st to October 30th, 1893.

The Royal Commission are now prepared to receive applications from artists, manufacturers, and others desirous of taking part in the Exhibition, to afford them all necessary information, and to offer them all available facilities which they may desire for this purpose.

Such applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, not later than February 29th, 1892, and addressed to the Secretary, as above.

As the funds granted by H.M. Government will not suffice to defray all the expenses of the Section, it is necessary that they should be supplemented by payments from the exhibitors. A charge will therefore be made to each exhibitor, based on the amount of space occupied, and calculated on the following scale:—

	Per sq. ft. s. d.
For spaces not exceeding 100 sq. ft. ..	5 0
For spaces exceeding 100 sq. ft. and not exceeding 200 sq. ft.	4 6
For spaces exceeding 200 sq. ft. and not exceeding 300 sq. ft.	4 0
For spaces exceeding 300 sq. ft. and not exceeding 500 sq. ft.	3 6
For spaces exceeding 500 sq. ft. and not exceeding 750 sq. ft.	3 0
For spaces exceeding 750 sq. ft. and upwards	2 6

The minimum charge will be £5.

It is not expected that the total receipts from all sources will more than suffice to defray the cost of an adequate representation of British industry; but should there be a sufficient surplus after the payment of all the costs of the Section, the Royal Commission will refund the balance *pro rata* with the amounts contributed by the several exhibitors. The amount produced by the payments of exhibitors will therefore be treated as a guarantee fund, to be expended if necessary, but if not, to be refunded to the contributors.

The Exhibition is situated in Jackson-park, within the southern limits of the city of Chicago. The principal buildings are devoted to the following main divisions:—(1) Fine Arts; (2) Manufactures and Liberal Arts; (3) Agriculture; (4) Machinery; (5) Electricity; (6) Mines; (7) Transportation; (8) Horticulture. In all these, space has been allotted to Great Britain, though it is expected that the principal British Court will be that in the Building of Manufactures and Liberal Arts, since the privilege has been conceded to this country of massing all or most of its exhibits together, should such a course prove desirable.

Exhibitors' goods will be transmitted direct in bond to Chicago, where the usual Customs examination will be made. Goods for exhibition only will not be liable to duty, but on goods sold the usual rates will have to be paid. Goods can be sold in bond, at prices independent of the tariff, the duties being payable by the purchaser.

The American railroad companies propose to carry goods back from the Exhibition free, charging the usual rates for the outgoing journey. These rates, it may be noted, are low in comparison with those usual in European countries. It is hoped that special terms for Exhibition goods traffic may be obtained from the Atlantic steamship companies. Full information as to routes, traffic, rates, &c., will be provided in due course.

A general Official Catalogue will be published in English, French, German, and Spanish. A special catalogue will also be published for the British Section.

Exhibitions of live stock will be held, and prizes will be offered in connection with them. A special circular has been issued, giving information about these.

A limited quantity of steam and water power will be supplied gratuitously. Further supplies will be provided at a fixed rate. Counter-shafts, pulleys, belts, &c., must be provided by the exhibitor. Application for motive power

must be made on special forms, which will be supplied on demand.

The general reception of articles at the Exhibition buildings will commence on November 1, 1892, and no articles will be admitted after April 10, 1893. Foundations for heavy machinery may be put in, and special constructive work commenced, as soon as the state of the ground and the buildings permits.

Special regulations will be hereafter issued for the organisation of the International Juries.

The Royal Commission are informed that the contract labour laws of the United States will not prevent exhibitors from importing foreign labour, or from entering into binding contracts with their *employés*. Further information on this head will be supplied on application.

Every person who becomes an exhibitor in the British Section thereby agrees to be governed by the rules and regulations laid down by the Exhibition Executive, or by the Royal Commission through its executive officer.

The last two articles on the Chicago World's Fair in *The Times* are devoted to an account of the buildings now in course of erection in Jackson-park, and to a description of the various routes in Chicago. The following notes are taken from these articles:—

The general state of preparation is at this time in a condition of unusual forwardness. Although the opening day is nineteen months off, yet it is surprising to see the way in which the work has been organised and is progressing. Chicago is accustomed to speed in the construction of big buildings, and her best building contractors are working in Jackson-park, and expect to have almost everything ready before the winter of 1892-3 sets in—five or six months before the opening. All the appliances are being made ready there for solid work at construction during the entire 24 hours of the day by the use of electric lights whenever necessary, and by having three sets of men, working eight hours each. The Americans are used to this sort of thing. They grow buildings almost like mushrooms, and Chicago stands at the head of the list for “pushing things” when required. Her best business men are in this enterprise, and give it the advantage of all their nervous energy. The headquarters of the Fair, in the “Rand-M’Nally Building,” which is just round the corner from the Board of Trade and in the heart of the busiest activity of Chicago, is a hive of industry working at high pressure all the time. Committees are in almost perpetual session, officials on long hours of duty, and here is conducted the

wide reaching executive business of the Fair. The energetic Director-General tells me everything will be ready in ample time, and, to show how forward matters are, he expects to send to the foreign commissions the plans of ground space of all the buildings in November, 1891, although the time fixed for that purpose is January, 1892.

A visit to the grounds in Jackson-park showed that the work of construction is rapidly proceeding. Entering the enclosure, which is surrounded by a high fence, the first thing that strikes the visitor is that the site presents the appearance of a vast railway freight yard, filled with tracks, on which there are many cars laden with timber, enormous iron beams, and other materials, whilst enough timber is piled about to build a large town. Chicago has the advantage of close proximity to the great "North Woods" of Michigan and Wisconsin, and there is no difficulty in fetching both by railway and vessel a wealth of cheap timber of the finest quality. Out of this wilderness of valuable materials on all sides is rising the framework of enormous buildings. A few patches of young trees are scattered about the surface, preserved in the landscape gardening. The basins and lagoons are filled with the bright green waters of Lake Michigan, glistening in the sunlight. Two or three dredges are still working at fashioning parts of their borders, but the main dredging is finished. The foundations of the buildings are upon heavy sand, with a stiff clay subsoil, furnishing a solid basis for the heaviest weights, and building materials are so cheap and plentiful that I was not surprised to find most substantial construction. There were altogether about 900 men working, who are generally housed at or near the grounds. This force will be increased to 2,000 men this month, and afterwards to 5,000 as the contractors get fully at work. The park is in charge of D. H. Burnham, Chief of Construction, a man of strong executive force, and said to be the best architect of large buildings in Chicago. The landscape gardening is directed by the veteran Frederick Law Olmsted, who is here, and who is the noted landscape gardener of Central-park, New York, and of the extensive system of Chicago parks.

Among the novel things contemplated is a "corn restaurant," designed to demonstrate to the world the palatableness and nutritious properties of Indian corn, the chief American cereal, as food for mankind. It will be cooked and served in every way known in this country, making most toothsome dishes, and Chicago hopes thus to extend the market for Indian corn and its products abroad. Just now the American corn crop goes abroad largely in the form of that natural package provided for its transmission, the American hog.

From New York there is a choice of several routes westward to Chicago. The traveller may take the Pennsylvania railroad, which is rather the shortest line and traverses the most populous region and the most diversified scenery; or he may go by the New

York Central railroad up the beautiful Hudson River and westward over New York State, halting at Niagara Falls before crossing the prairies beyond by one of the various Vanderbilt routes from Buffalo and Niagara to Chicago. Or the journey may be made by the picturesque line of the Erie Railway along the Delaware and Susquehanna and Chemung rivers and across the Genesee Valley to Niagara and the West; or by the Lehigh Valley line through the magnificent Lehigh and Wyoming valleys of Pennsylvania, and thence up the Susquehanna to Elmira, where the journey is continued on the Erie Railway. If a southern detour is preferred, the route by the Reading and Baltimore and Ohio railroads is available. There is also the Lackawanna line, and others. The visitor may perhaps land in Boston, and go west by the Hoosac Tunnel route, or by the Boston and Albany railroad through Massachusetts, joining the Vanderbilt roads at Troy or Albany. He may take the Grand Trunk system from Portland, in Maine, or on the St. Lawrence; and can also take the Canadian Pacific route to Chicago from Quebec or Montreal.

It will be seen there is no lack of railway routes with swift trains between the seaboard and Chicago, these being the "trunk lines," of which so much is heard. But while they are numerous, yet in the completeness of equipment and service, and the stability of roadway between New York and Chicago, the best routes are conceded to be the Pennsylvania or the New York Central, and they carry the greater part of the traffic.

Proceedings of the Society.

CANTOR LECTURES.

THE DECORATIVE TREATMENT OF NATURAL FOLIAGE.

BY HUGH STANNUS.

(Lecturer on Applied Art at University College.)

[THE RIGHT OF REPRODUCING THESE LECTURES IS RESERVED.]

*Lecture III.—Educated Nature.—Delivered
20th April, 1891.*

§ 20.—SELECTION.

The whole of the Vegetable Kingdom is at Man's use for decorative purposes; and some have supposed that the fact—of being a Flower—is sufficient reason for using every one. It should be observed, however, that, though the whole of the Vegetable Kingdom is at Man's service for Food; yet he selects one part and rejects the remainder. So also he has the right to select and reject for Decorative purposes.

For the ordinary Decorative Work, the Selection will be limited, by *æsthetic* considerations. All things in the Creation are beautiful when the mind understands sufficiently about them to be able to judge of their Fitness: that is, however, a *mental* quality which is assessed *after consideration*. In Decoration everything is judged by the eye of *sense*; and hence is felt to be right or wrong at the *first impression*. Therefore such Plants as are beautiful to the eye's first impression should be chosen.

Plants of ORDINARY GROWTH should be chosen: some Orchids, and other flowers, which appear to be *freaks of nature*, are interesting in scientific Botany; but are not useful in artistic Pattern-work. If the interest of the observer be attracted by the representation of a rare or abnormal flower in the pattern; and he proceeds to examine it closely, with the attention of a Botanist; and finds the representation so inadequate, as it must necessarily be as a consequence of the technical exigencies of Pattern-work—he is disappointed and tantalised. It is therefore better to avoid odd or rare plants, and to select those which are familiar and numerous.

SIMPLE PLANTS should be chosen: those which are too intricate and minute, either in Flower or Phyllotaxis should be avoided. In judging of this, we must take our material into consideration: flowers with much detail in stamen and pistil might be possible in Embroidery, but are impracticable in Mosaic; and leaves that are much divided are easy in Printed-work, but would be difficult to couch in Embroidery, and troublesome to fit in Inlaid-work.

SINGLE FLOWERS (*i.e.* those with one row of Petals) will be found most easy of treatment; and Double and Compound flowers should be avoided by the student. The Orientals have made most beautiful decoration with double flowers; but it should be remembered that they are not *beginners*: they have been Pattern-makers with flowers for centuries.

"GREENHOUSE-PLANTS" as a general rule, should be avoided; and also "Gardeners' flowers" without exception. The Gardener aims to produce something *new*: the Artist seeks to do his best with the old. The Gardener aims to produce *double* flowers: for the Artist the simple beauty of Nature suffices. The Gardener is delighted with the abnormal growth, which shall figure, with his name, in a Botanical magazine; the Artist is

balked by these exceptional specimens; he seeks—not the portrait of *one* extraordinary individual flower, but—the general effect of a well-balanced *pattern* made-up of many.

MALFORMATIONS should be avoided: such things are interesting scientifically as specimens in a Botanical Museum, but are useless and troublesome artistically in Decoration. People may pay a penny each to see six-legged lambs, but such objects are not introduced into Landscapes; and, for an analogous reason, freaks of nature should not be used in decoration.



FIG. 20.

PLANTS OF STRONG INDIVIDUAL CHARACTER should be avoided, as being not amenable in *Repetition*. The Lily, which appears most beautiful when, in solitary majesty, it graces the table in the Lady's Sanctum, is not always the most useful for Pattern-work.

THE SO-CALLED "ORNAMENTAL FLOWERS" should be avoided. About 30 years ago, when Decorative-Art was at a low ebb in England, several flowers were chosen and worked-up, by some Sculptors, into designs which were published. The flowers thus used were those whose chief characteristic was *form* rather than *colour*, *e.g.* the Con-

volvulus, Fuchsia, Ivy, Petunia, Geranium, &c. In fig. 20 (p. 906), which shews one of the best of them, the shadow-lines on the right-hand side of the stems, and the shading generally, prove that it is a *relief* rather than a colour treatment. The great objection is that the shapes are *too pronounced* to coalesce into the general *texture* of a pattern.

HACKNEYED FLOWERS should be avoided: there have been "runs" on the Sunflower, Vine, Ivy, Lily, Hawthorn, Convolvulus, &c.; and these might have a rest while the Student exercises his skill on others of the countless varieties around.



FIG. 21.

SYMBOLIC PLANTS which have been appropriated in connection with Religion should be avoided, unless required by the programme of the subject. A design for an Antimacassar, based on the Passion-flower, was once brought to the writer. The plant is beautiful, and suitable for decorative use in several materials; but the religious feelings of some would be hurt by that, and they should be respected. Those plants which have been assumed as Faction-badges are also subject to the same objection.

RAMIFYING PLANTS are most easy to

use in connected Pattern-work (the division into branches lending itself to the diffusion of the pattern-figure over the ground); and Bulbous plants are generally useful in Powderings (*only*).

SUPPLE PLANTS whose stems bend-about, are more easily treated than those with rigid stems and branches, that do not lend themselves to the decoration of any given shape. The various Decoratable-surfaces differ in shape; and the various plants differ in growth. The Student should therefore select such plants



FIG. 22.

for use as have sympathy with the given shapes. In Panels of ordinary shapes, any plant may be used; but in panels of extreme shapes, the choice is limited by the characteristic manner of growth of the different plants. Thus with a tall panel (say three feet high by six inches wide), the Flag lily and high Grasses would sympathise; while in a low panel (say six inches high, by three feet long), the Water-lily and short Grasses would be more suitable.

A SUFFICIENCY OF LEAVES, to overlap the stems at intervals—in order that they may

not be so *conspicuous* as in fig. 21 (p. 907)—is necessary. The Leaves are also useful in making masses in the composition.

LEAVES WHICH ARE BROAD in comparison with the Stems are good: when they are *narrow*, as is shewn in fig. 22 (p. 907)—there is a want of clearness; and the pattern may have a "liney" effect. It will be remembered that *line* and *shadow* are characteristic of Artificial foliage; while in Natural foliage *mass* and *colour* are necessary.

DISSIMILARITY BETWEEN THE LEAVES AND PETALS in mass-shape, edge-treatment, colour, or texture, is helpful: when the flowers and leaves are the same Shape or Colour—there is a want of Variety and of Clearness.

§ 21.—PRELIMINARY STUDIES.

The Preliminary Studies of the selected plant should be made from various points-of-view, carefully copying the method-of-growth and colour, &c., not only of the flowers and leaves, but of the branching; and they should be continued until the Student can draw the plant in all its detail from memory.

The normal appearance of the plant should be given as it is seen growing in the ground under ordinary circumstances, *i.e. in perspective* and not in the severe plan, elevation, and section, used in the Working-drawings of an Engineer.

The Botanical details should also be carefully noted, as viewed closely and on a level with it: these are, however, scientific statements of fact, to be used in *explaining* the appearances, but not in supplanting them.

After the careful studies of detail, some Brush-studies should be made. These are not to be drawn in pencil, but quickly blotted-in with the brush, at once. The Student need not, in these studies, attempt to match the colours of the plant: he may make them in monochrome, using any waste colour which may happen to be on his palate. Persevering practice gives power of seizing the characteristic masses of the plant; and further tends to induce somewhat of that marvellous dexterity in Brush-work, which makes our Japanese brethren such consummate Craftsmen.

The Scale of the representation should be the same as in Nature. This is only a particular case of the general rule that all pattern-work should be of the *same size* as Nature. The observance of this rule will prevent the selection of unsuitable plants; and also the unsuitable treatment of suitable ones. It is well that the Spectator should be able to

recognise the kind of plant which has been used; and preserving the Size conduces to this.

This rule may be made *elastic* to the extent of representing plants one-fifth larger or smaller than Nature (there is no virtue in one-fifth; but the line must be drawn somewhere). Also there may be *exceptions*: *e.g.* in decorating objects in the Precious metals (which by reason of their preciousness will be always of small size), and objects of Porcelain, &c. (which by reason of its perfection of surface will allow of minuteness). When the representation is smaller, it should be *distinctly smaller*, say one-third or one-fourth the size of Nature.

And the further Rule about reduction in Scale should be borne in mind:—that the decoration must be either all reduced to the *same scale* (*i.e.* if the flowers be $\frac{1}{4}$ full-size, then everything else must be $\frac{1}{4}$ full-size); or the decorative features which are of different scales must be applied in *different parts* of the scheme (*e.g.* say the smaller scale in the borders and other unimportant parts, and the larger scale in the panels, centres, and other important places), and there must be strongly-marked dividing-lines between them.

§ 22.—THE AIMS IN DESIGN.

The aims in Design with natural foliage should be:—

- (i) Clearness in the Composition (see § 23).
- (ii) Naturalness in the Treatment (see § 24).
- (iii) Acknowledgment of the prescribed Shape (see § 29).
- (iv) Distribution over the given Surface (see § 30).

The Rules which conduce to these are correspondingly divided. They are given suggestively to Students: the observance of them cannot be guaranteed to produce good designs; but it will probably prevent any very bad ones.

§ 23.—CLEARNESS OF COMPOSITION.

The representation of objects, by means of Drawing, is assisted by the following adjuncts:—(a) Light and shadow, (b) Local colour of each portion, and (c) Aerial perspective (*i.e.* the reduction in intensity of the colour according to the distance). When any one of these three is absent: then the onus of clearness is cast with additional weight on those that remain; and when all three are absent: then the Artist must give the whole of his consideration to the Drawing, in order that the absence of the *pictorial* may be compensated by the *decorative* clearness.

In Applied art some one or more of these adjuncts is generally not available; and the Artist endeavours to produce his work—with such slight alterations in the positions and attitudes of branches, &c., as shall conduce to decorative clearness without doing violence to the natural growth.

As a GENERAL DIRECTION: the student should not attempt to represent *subtle foreshortening* with incomplete technical Appliances: he can always move the flower or leaf a little, in order that the shape may be simple and “read” clearly.

Examples of the Faults, causing want of Clearness, which are most frequently committed, are shewn in fig. 23 (p. 910); and the accompanying diagram, fig. 24 (p. 911), shews a correction of each, for comparison. The numbers of the following paragraphs correspond to those on the former diagram.

1. THE OVERLAPPING OF FLOWERS by leaves or stems should be avoided. In looking at a plant the Spectator's glance is attracted firstly by the Flowers, secondly by the Leaves, and lastly by the Stems. If any flower be behind a leaf: he pushes-aside the leaf, or changes his position; and the Decorative treatment should do this for him. A Leaf may be permitted to overlap the lower part of a Flower; but a Stem should never do this. Fruit, when large, may be overlapped by leaves, because there is no small detail to be spoiled; and the overlapping takes-away their conspicuousness (see figs. 31 and 37, 4th lecture).

2. THE COVERING-UP OF THE GROUND by Leaves should be carefully avoided. When, with a thickly-leaved plant, it is not possible to shew ground all round each flower or leaf: then small portions of it should be left to shew-through between the leaves (compare fig. 29 with fig. 28, 4th lecture). It is not the *Ground* which is of importance; but that *sufficient of the shape* of the hinder leaves may be seen, so that they may be understood.

3. DOUBLE COMPLICATION should be always avoided. When all Leaves are flat, without twist or bend; and no leaf overlaps another—then the design is simple. The twisting or bending-over of a leaf is a complication; the overlapping of two leaves is also a complication; and both of these should not occur in the same place. The second leaf should cross behind a simple part of the front leaf, or should be moved-away to be clear, as shewn in the two instances.

4. THE ENDS OF LEAVES should not be covered, if possible. The bad effect, of the several instances of this, will be apparent.

5. COINCIDENCE OF EDGES, of Leaves or other portions, should be always avoided. When the leaf appears to lie along the side of another leaf or stem—then it should be pushed-away; as otherwise the equal width of the Ground-interstice would suggest a stem or vein; and Ambiguity would result.

6. COINCIDENCE OF CENTRE-VEINS between two petals, leaves, &c., should be always avoided; for the same reason as the former—that it attracts the attention and causes Ambiguity.

7. OVERLAPPING HALF-A-STEM should be always avoided. The overlapping feature should either be taken completely and frankly across the stem, or be pushed-away clear of it.

8. TOUCHING OF LEAVES, &c., should be avoided, when possible; and the parts should either frankly overlap, or be pushed-away.

9. AMBIGUITY OF STEM is displeasing. This may generally be avoided by pushing-aside the leaf, &c.

10. COVERING THE NODES should be avoided, when possible. In many plants—the stem, after throwing a branch in one direction, turns a little in the opposite direction, for the purpose of preserving its equilibrium; and this is more pleasing in a design when the cause is apparent.

11. PROMINENCE OF STEM should be avoided, unless that is a strong characteristic of the selected plant. They should be so arranged as to be visible on examination, but not at the first glance, which should be attracted rather by the Flowers or Fruit. The student should endeavour to carry leaves (often) to overlap across the stem, and flowers also (when possible), for the purpose of interrupting the lines it makes. If this be not done—then the lines would be too strong, and spoil the design.

§ 24.—NATURALNESS OF TREATMENT.

Naturalness of Composition, which is the second aim, may be considered as antithetical to Artificiality, the quality which results from “Art and Man's device”.

The contrast between these two qualities may be well observed on a pebbly beach. There, the pebbles are left by the receding tide distributed in confusion; but, after children have been at play, a great difference is observable. They have made “houses”; and the beach is no longer in confusion; but



FIG. 23.



FIG. 24.

shews arrangement, according to some law. The pebbles are in lines, at equal distances; the lines are straight, circular, or otherwise geometrical; the lines are parallel to each other, or at right-angles to each other; and everything is symmetrically disposed.

As distributed by the tide—the pebbles do not disturb the infinite *breadth* of Nature: they form a part of the *Mass* which is enriched in mottled texture by their presence. When arranged by the children—the pebbles seem to assert an *Individuality* apart from their fellows: they form *lines* which attract the eye and destroy the restful texture. This latter state is always a sign of the work of Man; and is right in its place where man congregates in towns. But when he seeks delight in Nature, and would bring some remembrance of it into his dwelling—he will avoid these disturbing qualities. Hence the necessity of the avoidance of Artificiality.

It is, of course, impossible to avoid *artifice* in the making of patterns; but the Pattern-artist may avoid the *appearance* of it. In this effort, he will ever find that the greatest Art is in concealing Art; and he should always strive towards that end—that though his work be full of thought: there shall be no trace of it, but all shall appear as if it had “grown so”.

Examples of the Faults, showing Artificiality, which are most frequently committed, are shewn in fig. 23; and the accompanying diagram, fig. 24, shews a correction of each, for comparison. The numbers of the paragraphs correspond, as before.

12. ALIGNMENT OF FLOWERS should be avoided. In Diapers, a certain amount of alignment is unavoidable; but this may be counteracted (see § 34). In fig. 23, the three flowers in a line are unpleasing. (See also fault 25 *seq.*)

13. EQUIDISTANCE should be avoided, especially between flowers.

14. AXIALITY OF FLOWERS, on stems other than their proper ones, should be always avoided. This often occurs in artificial diapers among the Persians and Chinese, but never in natural foliage.

15. SIMILARITY IN SIZE should be avoided, when possible. The flower 15 and that near 12 are too nearly alike in size. It would be well to introduce another flower, either larger or smaller, near one of them.

16. SIMILARITY or PARALLELISM IN ATTITUDE of flowers and leaves should also be avoided, when possible. This may generally be corrected by pushing one of the features a little to one side.

17. RIGHT-ANGLED CROSSING of Leaves or Stems should always be avoided.

18. EQUIDISTANT CROSSINGS of leaves should always be avoided: when the lengths from the intersection to the tips of leaf are equal, then one leaf should be pushed-away to alter this.

19. DOUBLE-INTERSECTIONS (*i.e.* the intersection of three lines in the same point) should always be avoided, whether it be the intersection of the centre-veins (as in fig. 23) or of the edges.

20. THE COMMENCEMENT OR TIP of a leaf should not coincide with an under-lying or over-lapping stem or other feature. The example of each of these faults will show the artificial effect of this.

21. OPPOSITION OF AXES or centre-veins, in leaves and flowers, &c., should be always avoided. The bad effect of this in natural foliage is so obvious that it is rarely perpetrated.

22. CENTRALITY OF POSITION in flower or leaf should be always avoided. The two instances, in which the leaf is central between other features, will demonstrate this.

23. ACCIDENTAL RADIATION should be always avoided. This results from the meeting-together of the leaf-tips; and can always be obviated by pushing-aside.

24. SYMMETRICAL BRANCHING should be avoided. This is undoubtedly one of the facts of Scientific Botany; but for *Artistic* purposes, a point-of-view should be chosen which avoids it. The two examples in branching, and the one in the position of leaves, are all corrected in fig. 24.

25. ALIGNMENT OF EDGES in leaf or flower should be always avoided in the *inner parts* of a pattern. It has a great value, when used round the *outside*, against the bounding-lines of a Panel or Border, in giving Parallelism (see figs. 26, 29, and 36, 4th lecture); but when applied to the innermost leaves of a panel—it makes a *line* which cuts the panel in pieces.

26. STRAIGHT LINES in the stems should be avoided, when possible, especially if *horizontal* or *vertical*. In using plants which have rigid stems, this is not always practicable; but they may generally be bent or be pushed a little out of the perpendicular; and when *oblique* are not so objectionable.

27. GEOMETRICAL AND CONTINUOUS CURVES in the stems should be avoided, when possible; and fragmentary indeterminate ones should be sought-for, and used (see fig. 20 for fault).

28. PARALLELISM BETWEEN STEMS should be always avoided. This is a common fault; and the artificiality is very damaging to the naturalness of a design.

29. INTERLACEMENT OF STEMS should be avoided. This does not seem out-of-place when recurring regularly in Byzantine or Scandinavian work; but an isolated instance in Natural foliage will give an Artificial air which is incongruous. Sometimes the Roots or starting of the stems are interlaced in an artificial manner. These parts cannot be made too simple; the torn bark is the most natural.

§ 25.—EDUCATED NATURE.

These methods of Selection and Arrangement, which are termed "educating" the natural foliage, do not necessarily demand either the Realistic or the Conventional methods of representing the plant; but may be used with either. Thus there may be an arrangement of Flowers "*realistically*" represented, which is educated so that it may pleasantly and efficiently decorate a space; and the same arrangement might also be *conventionally* represented, and equally be good decoration.

§ 26.—NOTE ON ANALOGY.

It will probably have been observed that these suggested Rules are analogous to the little acts of selection and adjustment which the landscape-painter (*unconsciously*) and the historical painter (*consciously*) practise.

The foregoing Suggestions are all *negative*. No positive rule is necessary in the treatment of Nature, if the Student will use and *not abuse* the riches that lie at his feet. These rules are all to the end that the design be kept clear (*i.e.* simple and easy to comprehend) and natural (*i.e.* that he shall withhold all artificial interferences of his own ideas) and shall give Nature a chance. He cannot, by taking thought, improve upon it: he should see that he does not, by extraneous treatment, spoil its beauty.

Miscellaneous.

NEW SOURCES OF PIASSAVA.

It is reported that the decline in the supply of Bahia piassava still continues, and that the bark is becoming exceedingly scarce, owing to the reckless

manner in which the trees are stripped. Bahia piassava, as is well known, is the fibre from the sheathing bases of the leaves of a palm (*Attalea funifera*), and is a most valuable material for the manufacture of bass brooms and brushes. A similar product, obtained from Para, is furnished by another palm, the *Leopoldinia piassava*. In consequence of the scarcity of these two commodities, attention has of late years been directed to other channels for substances that might compete with, or, any rate, be used as a substitute for true piassava. One has been found in Madagascar, the fibres of which are, however, not sufficiently stiff or elastic to be used by themselves. Split cane, dyed brown to resemble piassava, has also been used, more, perhaps, for mixing with the real thing than to be used alone. But the most recent introduction, and one of very considerable importance, is that now known in commerce as African piassava, or Lagos bass. It differs from the other three kinds, inasmuch that, instead of being a fibrous coating or sheathing at the *base* of the leaves, it is the strong woody fibres of which the petiole, or leaf stalk, are built; and as the palm (*Raphia vinifera*) is now abundant in tropical Africa, the supply is practically inexhaustible. With this consideration, coupled with the fact that the substance continues to arrive in large quantities, and to meet with a very ready sale, it may be taken that African piassava is one of the most important of newly discovered vegetable products.

FIBRE-CLEANING MACHINES IN THE BAHAMAS.

The United States Consul at Nassau says, in his last report, that the development of the fibre industry in the Bahamas has already necessitated the introduction of machines for separating the leaf of the sisal, or pita plant, and the demand for other machines in the future will be very great. The machines heretofore in use are of English manufacture principally, and they do not seem to have satisfactorily met the requirements of the case. In using these machines, the leaf is presented to a scraping which removes the pulp, gum, &c., from about three-fourths the length of the leaf, leaving the fibre cleaned from that portion. The leaf is then withdrawn, and the other end is presented to the wheel and cleaned in the same manner. The cleaning of each leaf thus requires two handlings by the operator, making the entire process tedious and expensive. During the month of June last, two Americans arrived in the colony, bringing with them, and introducing a new automatic fibre-cleaning machine. On the 25th June a large number of persons interested in the fibre industry were present, including representatives from many

other islands, where the largest plantations are being cultivated. Considerable difficulty was experienced in getting the machine to run properly, owing to the fact that the steam plant used was defective, and the pulley and belts were not of the proper size, width, &c. But, despite these drawbacks, the operation of the machine was said to be decidedly satisfactory, and nearly all present were of opinion that, under proper conditions, the machine would very easily do all that was claimed for it, and that it was a most valuable improvement over all other machines in use in the colony. The new machine is entirely automatic. It grips the leaves continuously as fast as the operators can supply them, holds them firmly during the operation of cleaning, and delivers the fibre completely and beautifully cleaned at the reverse side. No reversing of the leaves or of any part of the machinery is required. The operator simply supplies the leaves, and the machine does the rest. It works smoothly, easily, and rapidly, and its capacity is enormous. One of the machines previously in use in the Bahamas will clean about 3,000 leaves in ten hours, extracting 180 lbs. of fibre. The new automatic machine is said to be capable of cleaning 50,000 leaves a day, extracting therefrom 3,000 lbs. of fibre. Skilled labour is not required to work the machine; an engine of 8 horse-power will furnish all the motive power required to run it at full speed. It is not a complicated affair, nor is it, it is said, likely to get out of order. Its weight is about 6,000 lbs. In conclusion, Consul McLain says: "As the sisal plantations are mostly new, and cannot come into general bearing under two or three years' time, this ingenious machine, on account of its enormous capacity, can scarcely be used with advantage in the Bahamas at present, but in countries where the supply of leaves is ample, it will doubtless be rapidly and extensively introduced."

Obituary.

[MR. WILLIAM ALEXANDER BARRETT, who has acted as the Society's Examiner in Music since 1879, when he succeeded Dr. John Hullah, died very suddenly on the 17th inst. The deceased musician, born at Hackney in 1836, had a very long connection with St. Paul's Cathedral, of which he became a chorister at an early age, subsequently attaining, and till death holding, the position of a vicar choral. In 1867 he succeeded Mr. Sutherland Edwards as critic of the *Morning Post*, a post which he retained until his death, for he reported the Birmingham Festival not a fortnight ago. In 1870 he took the degree of Mus. Bac. at Oxford, and afterwards he obtained a Colonial degree of Mus. Doc. He produced many works on musical subjects, including "English Glee

and Madrigal Writers," "English Church Composers," "Balfé, his Life and Works," &c.; and, jointly with Dr. Stainer, a "Dictionary of Musical Terms." For some time Dr. Barrett edited the "Monthly Musical Record," later on succeeding Mr. H. C. Lunn as editor of the *Musical Times*. Mr. Barrett was, moreover, widely known as a lecturer, especially on old English ballads and songs—his knowledge of which was extensive—and also as Assistant Inspector of Training Schools, first under the late Mr. Hullah, and next under Sir John Stainer.

General Notes.

TECHNICAL HORTICULTURE.—A joint committee of the Gardeners' Company, of which the Lord Mayor is Master, and the Royal Horticultural Society, have for some time past been considering the subject of the establishment of a British school and college of technical horticulture and small husbandry. They have now drawn up a scheme for adoption. This provides that the general objects of the school should be to impart a higher class of education in the principles and practice of the cultivation of fruits, flowers, vegetables, &c., than is at present obtainable in Great Britain, to (1) persons wishing to qualify themselves for employment in gardening and garden-farming in this country; (2) the sons of landed proprietors, farmers, and others who are interested in gardening; and (3) persons who may be desirous of emigrating, or may be already resident in the colonies. Preference will be given to students of British birth. No student will be admitted who does not already possess some elementary practical knowledge and experience of gardening or garden-farming. All students will in ordinary circumstances be expected to continue their studies for at least two years. The object being to impart a thoroughly practical education in gardening, all students must be prepared to devote themselves to the manual, as well as to the scientific, branches of the work, and to yield implicit obedience to the directors. Efficient directors will superintend the instruction in the various branches of cultivation, and lectures on the scientific aspects of gardening and farming will be delivered by qualified persons, and illustrated by practical demonstrations. To attain these objects it is proposed that the Gardeners' Company and the Royal Horticultural Society should secure suitable land where experimental and practical gardening may be carried on, pending which arrangements are being made to utilise the gardens of the Horticultural Society at Chiswick for the instruction of students in connection with the scheme.

Journal of the Society of Arts.

No. 2,033. VOL. XXXIX.

FRIDAY, NOVEMBER 6, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirty-eighth Session of the Society will be held on Wednesday, the 18th November, when the Opening Address will be delivered by the ATTORNEY-GENERAL, M.P., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made :—

ORDINARY MEETINGS.

NOVEMBER 18. — Opening Address by the ATTORNEY-GENERAL, M.P., Chairman of the Council.

NOVEMBER 25. — PROF. SILVANUS P. THOMPSON, F.R.S., "Measurement of Lenses."

DECEMBER 2. — G. H. ROBERTSON, "Secondary Batteries."

DECEMBER 9. — JAMES DREDGE, "The World's Fair at Chicago, 1893."

DECEMBER 16. — PROF. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention."

Papers for which no dates have yet been fixed :—

"The Scientific Value of Lovibond's Tintometer." By F. W. EDRIDGE-GREEN, M.D.

"Burning Oils for Lighthouses and Lightships." By E. PRICE EDWARDS.

"Dust, and How to Shut it Out." By T. PRIDGIN TEALE.

"Typological Museums." By GENERAL PITT RIVERS.

"Iceland." By T. ANDERSON.

"Artistic Treatment of Jewellery and Personal Ornament." By T. W. TONKS.

"Agricultural Banks for India." By Sir WILLIAM WEDDERBURN, Bart.

"The Agricultural Needs of India." By Dr. J. ANGUS VOELCKER.

"Travels in India and China." By LORD LAMINGTON.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at Half-past Four o'clock :—

January 19, February 16, March 15, April 5, 26, May 24.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday afternoons, at Half-past Four o'clock :—

January 21, February 11, March 3, 24, April 28, May 19.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock :—

January 26, February 23, March 8, 29, April 12, May 17.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock :—

A. P. LAURIE, "The Pigments and Vehicles of the Old Masters." Three Lectures.

November 30, December 7, 14.

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.

January 25, February 1, 8, 15.

PROF. WILLIAM ROBINSON, Mem.Inst.M.E., "The Uses of Petroleum in Prime Movers." Four Lectures.

February 29, March 7, 14, 21.

BENNETT H. BROUGH, "Mine Surveying." Three Lectures.

March 28, April, 4, 11.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bacteriology of the Fermentation Industries." Four Lectures.

May 2, 9, 16, 23.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday evenings, at Eight o'clock, by PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

February 5, 12, 19, 26, March 4, 11.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, January 6 and 13, 1892, at 7 p.m.

EXAMINATIONS.

Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Political and Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

Chicago Exhibition, 1893.

A meeting of the Royal Commission was held on Friday, October 30. Present: the Attorney-General, M.P., in the chair; Prof. W. C. Roberts-Austen, C.B., F.R.S.; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.; Sir Frederick Bramwell, Bart., D.C.L., F.R.S.; Michael Carteighe; R. Brudenell Carter, F.R.C.S.; Lord Alfred S. Churchill; B. Francis Cobb; Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E.; Prof. James Dewar, M.A., F.R.S.; Major-General J. F. D. Donnelly, C.B.; Sir Henry Doulton; James Dredge; Francis Elgar, LL.D.; Sir Douglas Galton, K.C.B., D.C.L., F.R.S.; C. M. Kennedy, C.B.; John Biddulph Martin; W. H. Preece, F.R.S.; Sir Owen Roberts, M.A., F.S.A.; Sir Saul Samuel, K.C.M.G., C.B.; with Sir Henry Trueman Wood, Secretary.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

The Royal Commission are now prepared to receive applications from manufacturers, and others desirous of taking part in the Exhibition.

Such applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, not later than February 29th, 1892, and addressed to the Secretary, as above.

As the funds granted by H.M. Government will not suffice to defray all the expenses of the Section, it is necessary that they should be

supplemented by payments from the exhibitors. A charge will therefore be made to each exhibitor, based on the amount of space occupied, and calculated on the following scale:—

	Per sq. ft.	s.	d.
For spaces not exceeding 100 sq. ft. ..	5	0	
For spaces exceeding 100 sq. ft. and not exceeding 200 sq. ft.	4	6	
For spaces exceeding 200 sq. ft. and not exceeding 300 sq. ft.	4	0	
For spaces exceeding 300 sq. ft. and not exceeding 500 sq. ft.	3	6	
For spaces exceeding 500 sq. ft. and not exceeding 750 sq. ft.	3	0	
For spaces exceeding 750 sq. ft. and upwards	2	6	

The minimum charge will be £5.

It is not expected that the total receipts from all sources will more than suffice to defray the cost of an adequate representation of British industry; but should there be a sufficient surplus after the payment of all the costs of the Section, the Royal Commission will refund the balance *pro rata* with the amounts contributed by the several exhibitors. The amount produced by the payments of exhibitors will therefore be treated as a guarantee fund, to be expended if necessary, but if not, to be refunded to the contributors.

A prospectus giving further information can be obtained at the Society's offices.

DEPARTMENT OF LIVE STOCK.

An important department of the Exhibition will be that devoted to the exhibition of live stock. Money prizes are offered of various amounts, reaching in the aggregate a sum of £50,000, in addition to medals, provided by the Columbian Commission, will be awarded on the reports of international jurors.

A pamphlet, giving a schedule of prizes and full details, has been published by the Chicago Executive, and copies of it can be had on application at the Offices of the Society of Arts.

The following Memorandum is a summary of this pamphlet. Further information relative to the exhibition of animals from foreign countries will be issued as received:—

SUMMARY OF RULES AND INFORMATION RELATIVE TO THE EXHIBITION OF LIVE STOCK.

The exhibition of live stock will include, under certain restrictions, animals of every species, breed, variety, or family, domesticated or otherwise.

Money prizes will be offered and medals awarded, subject to the general system adopted by the Exhibition authorities, for the following classes, viz.:—Cattle, horses, sheep, swine, dogs, poultry, pigeons, and pet stock, and any additional classes which may subsequently be decided upon.

The live stock exhibit will begin August 24th, and close October 30th, 1893; and the period devoted to the exhibition of animals for award will be as follows:—

- A. Cattle—September 11th to 27th.
- B. Horses—August 24th to September 6th.
- C. Sheep)
- D. Swine) October 2nd to 14th.
- E. Dogs—June 12th to 17th.
- F. Poultry, Pigeons, and Pet Stock—October 18th to 30th.

Exhibitors must in each case file an application showing that they have owned the animal offered for entry for a period of at least sixty days prior to the date of such application, giving the name, age, and a description of the animal.

In Divisions A to D exhibitors must also furnish a copy of the certificate issued by the Association, in whose registry the animal to be entered is recorded, or show that the animal offered for entry is a representative of some recognised breed or variety, and give such further information as may be required.

In Division E exhibitors are required to give satisfactory evidence that the animals offered are recorded, or are eligible to record, in some organised stud-book, in which purity of breeding is the basis of registration. Acceptance of exhibits in this class is subject to the approval of a Special Committee appointed by the Exhibition.

In Division F poultry exhibits will be admitted under the rules governing the admission of fowls at competitive displays in the country exhibiting. Pigeons must be named correctly, and be exhibited in their natural condition. Entries of certain specified varieties are to consist of single birds: other varieties to be entered in pairs. All birds entered for competition must be the property of the exhibitor.

In Divisions A, B, C, and D no exhibitors will be allowed more than two entries in any one exhibition ring, *i.e.*, two 1 year old, two 2 year old, &c.

The age of animals is to be calculated to the opening day designated for the exhibition of the division in which they belong.

In the case of animals from foreign countries, applications for entries in all divisions will have to be made through the commissioner for each country. All applications, except in Division E, must reach the Chief of the Department of Live Stock at Chicago on or before June 15th, 1893. Applications for entry in Division E will close May 20th, 1893.

Any exhibitor wilfully misrepresenting any fact in connection with an entry, or otherwise attempting to defraud the Exhibition, will be debarred from any

competition in this department, and his exhibit will be removed from the grounds.

The Chief of the Department of Live Stock can exclude any animal not considered to be a typical representative of its kind, and also order the removal of vicious or fractious animals.

The Exhibition authorities will not hold themselves responsible for any injury to, or for the death, of any animal exhibited.

Accommodation for the exhibition of live stock will be provided by the Exhibition authorities, who will also appoint a veterinary surgeon and assistants, who will examine all animals before admission to the Exhibition, and make a daily inspection of the grounds and stables, and cause all sick animals to be removed to a separate enclosure.

Ample facilities will be provided for the conveyance and distribution of water throughout the grounds, and forage and grain will be furnished at reasonable prices at depôts conveniently located about the grounds.

Exhibitors will furnish their own attendants, and will be required to keep the stalls occupied by their exhibits and the grounds adjacent thereto thoroughly clean.

Animals will be exhibited for award in the amphitheatre erected for such purpose.

In case of doubt by any jury or committee as to any essential fact in connection with the entry of an animal, satisfactory proof in writing must be furnished by the exhibitor: should the evidence submitted be unsatisfactory, such animal will be barred from competing in any class or division of the Live Stock Department.

The awards made by any jury or committee shall be final.

Animals will be subject to quarantine regulations.

An official catalogue will be issued by the Exhibition.

Further special regulations relative to Divisions E and F will be issued later.

Proceedings of the Society.

CANTOR LECTURES.

THE DECORATIVE TREATMENT OF NATURAL FOLIAGE.

BY HUGH STANNUS.

(Lecturer on Applied Art at University College.)

[THE RIGHT OF REPRODUCING THESE LECTURES IS RESERVED.]

*Lecture IV.—Application.—Delivered 4th
May, 1891.*

§ 27.—SHAPES, AND THEIR DECORATION.

The decoratable SURFACES on which natural

foliage is applied are classified, according to their shape, position, and function, as :—

- Panel,
- Border,
- [Band]
- Frieze, and
- Indefinite shape and form.

The DECORATION which may be applied to these surfaces is classified, according to its suitability to the above shapes, as :—

- Panel ornamentation,
- Border ornamentation,
- Frieze ornamentation,
- Diapers,
- Body ornamentation, and
- Free ornaments.

A PANEL is a portion of surface which is bounded on all sides by Enclosing-lines. These lines are or represent the original Constructive Frame; and may be in *colour* (as in Surface decoration), or in *relief* (as in Architectural work); and they preclude any extension of the surface.

PANEL-ORNAMENTATION may be rich in character. Panels are not a functional part of construction; and they are generally chosen as the place for the most elaborate work and the highest beauty. Their position with regard to the horizon governs the attitude of their ornamentation: when in a *vertical* plane (as on a wall) then it may be in a vertical attitude and axial objects may be introduced; and when *horizontal* (as in a ceiling, table, or floor) then it will be indeterminate in attitude. Panel-ornamentation should be complete in each Panel or Set of panels.

A BORDER is a portion of surface which is divided-from, or surrounds the Panel. The surface, from which it is divided, may be horizontal, vertical, or at any angle to the horizon; and the border may be in any attitude on that surface. A Border is generally enclosed on its outer and inner edges (*only*), by lines (which are usually *parallel*); and it is capable of extension in a lateral direction.

BORDER-ORNAMENTATION should be severe. Borders are generally considered as being analogous to the Framing; and thus, being *functional*, should be subordinated to the Panel. Their variability-of-attitude further restricts the class of elements, and only permits such as may be reversed in attitude without incongruity. Border-ornamentation should be capable of lateral extension, governed by the principle termed *Répétition*; and of change of direction at the Angles.

[BANDS are mentioned, for the purpose of completing the classification; but they are strictly functional, and will, therefore, not be treated with natural foliage.]

A FRIEZE is a portion of surface which is specially marked-off and set-apart for enrichment. The surface, from which it is marked-off, is always vertical in position; and the frieze is always horizontal in attitude on that surface. A Frieze is always enclosed by lines at its upper and lower edges, which are always parallel; and it is extended laterally.

FRIEZE-ORNAMENTATION is generally rich in character. Friezes are not functional; and are often treated with the same elaboration and beauty as Panels. Their invariable verticality of attitude permits a higher class of elements than is appropriate to Borders. Frieze-ornamentation should be capable of lateral extension, governed by the principle termed *Series*; and of change of plane at the Corners.

INDEFINITE SHAPES are those portions of Surface (*i.e.* of *two* dimensions) which are not bounded by Enclosing-lines, and which therefore do not belong to any of the classes of Panels, Borders, &c.; *e.g.* a breadth of Wallpaper, or of Carpet, &c. These are generally treated with either Free ornaments, or Diapers.

INDEFINITE FORMS are those portions of the surfaces of Objects (*i.e.* of *three* dimensions) which remain when the Friezes, Bands, &c., are divided-off. The term is applied more particularly to those Objects which are *not constructed of framing* and which are *circular* or *polygonal in plan*; *e.g.* the body of a Vase or of an octagonal Pedestal. In one sense they are enclosed by lines, *i.e.* by the Bands round the Body at top and bottom. The surface is however *continuous*; and is, therefore, distinct in character from the Indefinite Shapes, which are primarily flat surface (*only*), and are not required to meet or join in their decoration.

DIAPER-ORNAMENTS are those that are capable of indefinite repetition. Each complete unit of the diaper is circumscribed by lines, which form an oblong or a regular geometrical figure. These lines are termed the Repeat-lines. It is not necessary that the Pattern-figure should shew *Parallelism* to them: more often, *e.g.* in Textile fabrics, the Repeat-lines cut through leaf and flower indiscriminately.

BODY-ORNAMENTATION may be rich in character on Vases, &c.; and reticent on Pedestals, &c. It is not specially func-

tional; and may receive elaborate ornamentation as a high Frieze, or be plain; according to the nature of the Object. Free-ornaments are sometimes used on the Bodies of Vases, &c., and occasionally Diapers; but these latter are uninteresting, and often difficult to apply. Decoration which has some *subject or meaning* is obviously the best for this.

FREE ORNAMENTS are those whose mass-shape is so varied that it cannot be enclosed by simple geometrical lines. They may be *single* (e.g. the Tripod-support on the Choric Monument of Lysikrates); or *repeated* (e.g. the Wave-scroll above the cornice of the same Monument). They may be seen *against-the-light* (e.g. the above two examples), or *en-crust-ed* over mouldings, &c., or in the centres of panels, examples of both of which are to be seen over the side-windows in the ground-story of the front of St. Paul's; or otherwise applied in interior decoration. In each of these instances, there is no attempt to make the ornament show any parallelism: it is unconfined or *free*; and makes no pretence of filling or occupying the shape of the panel or other space. Any Decorative element which is thus used should be *high* in the scale of elements; and the motive of its application should be *Didactic* rather than merely *Æsthetic*.

§ 28.—APPLICATION OF DECORATION TO SHAPE.

When natural foliage is applied to an object, for the purpose of Decoration—then it may be so treated as to appear to acknowledge the *SHAPE* in which, and the *SURFACE* on which, it is used.

It may be said to do this in two manners:—

- (i.) When it is kept within the limits imposed by the Enclosing-lines. This is effected by arranging the growth of the branches, leaves, &c., in such a manner that the plant appears to have ceased growing when the extreme leaves approached the enclosing-lines; that there is, therefore, neither pushing-against and growing-over, nor mutilation of the plant, for the purpose of fitting-in to the given shape. This quality (and the principle which governs it) is termed *PARALLELISM*.
- (ii.) When it is spread or diffused over the enclosed Surface. This is effected by arranging the direction of the branches with their leaves, &c., in such a manner

that no part of the enclosed surface appears bare or unoccupied while another part appears dense and crowded with foliage. This quality (and the principle which governs it) is termed *DISTRIBUTION*.

§ 29.—PARALLELISM.

PARALLELISM is an important Principle in the application of foliage to enclosed shapes. All decorative art which appears to acknowledge the given shape produces the impression —of having been *made for its place*; and it is thereby more pleasing than if it gave the effect —of being a *portion* that had been cut-off from a larger panel.

To attain this: it will be well for the Student *after* the Foliage is drawn in the given Shape, to test the parallelism by drawing lines all round inside the latter, and parallel to it at a distance of about a quarter of an inch (this distance depends on Proportion, and is determined by judgement). He will then be able, should any leaves, &c. overlap this parallel-line, to re-draw and move them back; and should any not approach it sufficiently near, to bend-out the stems. Flowers and leaves may also be turned; and portions may be cut-away. These adjustments must be done with judgement; and the natural growth must be always adhered-to.

This practice—of bending-about or *educating* the branches and stems, so that they may perform their share of the duty in decoration—gives the name to this method of treatment.

The example, fig. 25 (p. 920), shews a branch of Laurel painted as a study from Nature. It will be seen that it is in Semi-pictorial Realism (as defined in § 11); but it is not yet *decorative* inasmuch as there is no acknowledgment of the framing or limit.

In fig. 26 (p. 921), the leaves have been “educated”, for two reasons:—firstly, to give Clearness (see § 23); and secondly Parallelism (see § 29). Some of them have been turned, for the purpose of obviating subtle foreshortening (see § 23); and some have been moved, for the purpose of allowing the ground to shew-through (see § 23). Other leaves have been added at the lower part, for the purpose of occupying the shape (see § 30).

Fig. 27 (p. 922), which is adapted from this, shews further modifications for the purpose of occupying the given shape, which is a Border. (This is the original of figs. 7, 8, 9, 18, and 19.)

The Panel, fig. 4 (p. 864), shews a looseness of effect resulting from the want of more atten

tion to this principle. Some attempt at it will be observed along the top of the panel; but the severe application of the Symmetry makes the looseness of the Parallelism more apparent. Fig. 5 shews an improvement: the parallelism

is felt along the top and bottom, and at the sides near each angle; the only places without it being in the *centre* of each side, *i.e.* at axial positions.

The eye is pleased at these variations,



FIG. 25.

caused by suspending the Principle, provided they arise *from intention and not from inability*. That this has been the case is evident from two reasons:—(i) The space is

at axial points; and (ii) the space is left unfilled by the Ribbon (which is only accessory), and not by the Foliage (which is principal).

§ 30.—DISTRIBUTION.

DISTRIBUTION is a principle that is more important in those applications of foliage which do not require Parallelism, *e.g.* in Diapers. In these: Evenness of diffusion is

necessary; and any larger ground-spaces that produce the impression of being "holes" are to be avoided. It has also a certain value in enclosed-shapes, especially when varied in density (see § 32).



FIG. 26.

There are degrees in the extent to which these principles may influence the application;

and these are characteristic of the three style shewn in figs. 28 to 30 (pp. 923-4-5).

In the example of the INDIAN style, fig. 28 (p. 923)—the Parallelism is completely carried all round inside the Enclosing-lines; and the Distribution is so uniform that all the interstitial Ground-spaces are of approximately equal area. This is the one extreme—of evenness and density.

In the example of the JAPANESE style, fig. 30 (p. 925)—neither Parallelism nor Distribution is seen. This is the other extreme—of irregularity and sparsity.

In the example of the ENGLISH style, fig. 29 (p. 924) (adapted from the preceding)—the Parallelism is felt at the angles where the branches approach the Enclosing-lines. This is sufficient to give an appearance of *steadiness* to the design, and to shew that it has been made for that particular shape, without carrying the foliage closely *all round* it; while the Distribution is varied, the Ground-spaces being of differing areas. This design is well *balanced*; and it appears to occupy a middle place in the scale between the uninteresting "texture" of the Indian and the irregular "spotting" of the Japanese.

The characteristics of the three may be stated briefly:—

The INDIAN *fills* the shape;

The JAPANESE *ignores* the shape;

The ENGLISH *occupies* the shape, combining the Obedience of the first with the Freedom of the second.

The INDIAN is the treatment which might have been expected from the ancient patient rice-eating millions down-trodden for centuries. It is seen in the exquisite work in the India Museum.

The JAPANESE with its strong individuality and (*apparent*) irregularity is the result of their artistic schools working on traditional lines. The typical method generally ignores the given shape by placing the Plant-form with a studied appearance of irregularity; and often contravenes it by carrying a branch across the Enclosing-lines; and not seldom the work gives the impression of its being a *small piece cut-off from a larger*. The resulting Fancifulness is charming—when the irregular feature is the most important in the composition; when it is so beautiful in execution as to repay the attention which is attracted by the irregularity; when there is no repetition; and when it is seen for the first time. It should be borne in mind, in judging of Japanese work, that the greater portion of their hand-made Flower-work is intended primarily as *Symbols* (each plant and

each attitude of the foliage having its meaning and association), and only secondarily as *Decoration*. [It will be remembered that—while *Æsthetic* work is governed by the shape and surface—Didactic work is concerned with

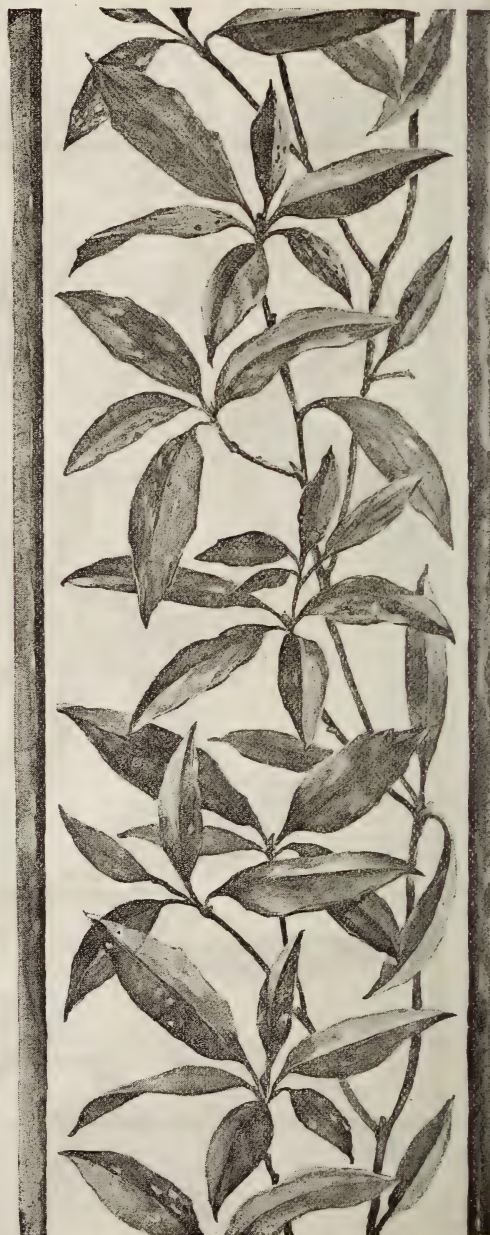


FIG. 27.

the meaning, and ignores the shape.] When, however, the same quaint features and treatment are mechanically repeated—the practice soon degenerates into an irritating affectation.

Fig. 4 shews bad Distribution: there are

vacant spaces in the inner part of the panel, which are displeasing. If the ribbon were reduced, and the foliage increased in quantity to occupy more at the centre and at the lower angles, the effect might be more pleasing.

The above remarks have reference to the Distribution of the *whole* of the features of the plant over the given Shape. There is, however, a higher kind of distribution—the

Placing of the Flowers among the Leaves—which is more difficult. But inasmuch as the Flowers, by their scarcity (as compared with the numerousness of the leaves) and by their colour (as compared with that of the leaves) are more conspicuous: the arrangement of them in the given Shape and over the Surface is of the highest importance.

There should be a feeling that they are



FIG. 28.

scattered over every part of the given Shape, though not in positions which would be likely to attract attention. In many cases, the Flowers are at the *top* of the Plant; but, if in any Panel the flowers were at the top (*only*), then there would be a want of distribution. Hence the expedients of short stems and bent stems are resorted-to. Other expedients that are less justifiable are also used; and in

regard to these it should be remembered that it is the clumsiness causing the detection which is here the crime. The position of the Flowers should be considered, however, in selecting the Plant.

§ 31.—PANELS.

PANELS, being never functional, and always important, are not treated so severely as other

shapes. A Panel is usually the largest space in an object. It allows of the greatest variety of treatment in Distribution, &c.; and demands the highest beauty of Realism or of some degree of it. It is never *flush* with the Framing or general surface of the object, but usually recessed; and this loss of coincidence-

of-surface seems to allow of the still further (apparent) loss or annihilation of surface by the Pictorial treatment. The Enclosing-lines seem to necessitate some attention to Parallelism; but it should not be so severely applied in Panels as in the more functional Borders.



FIG. 29.

In PANEL ORNAMENTATION any appearance of Artificiality in position or attitude is to be carefully avoided.

Repetition is never appropriately applied to the high-class features which are used in panels.

The attitudes of leaves near the Enclosing-lines should be varied, to avoid Artificiality, and Monotony.

Flowers afford a good opportunity of obtaining beautiful colour in Panels. Artificiality in their Position should be always avoided. In addition to the general rules in § 24, the following treatments should be always avoided:—

- Flowers on the same vertical line;
- Flowers on the same horizontal line;
- Flowers in similar positions, *e.g.* in opposite angles.

Parallelism of the Stem to Enclosing-lines should always be avoided: it attracts attention; and produces the effect of dividing the panel.

Axiality of the Stem in the centre of Panel should be avoided, when possible; and when necessary the stem should be slightly bent, to destroy any possibility of Symmetry.

Proximity of the stems to the enclosing-lines should be always avoided. They attract attention; and do not allow space for the foliage to overlap them, as mentioned in § 20.

§ 32.—BORDERS.

BORDERS are (generally) functional, performing, so to speak, the duty of a wall in



FIG. 30.

surrounding and fencing-in the ornamentation of the Panel.

BORDER-ORNAMENTATION should, therefore, be *connected* and not fragmentary. It should be always subordinated to the panel, in beauty of composition and colour; and never treated in a Pictorial manner so as to lose the surface.

The general lines of Growth should be *longitudinal*, i.e. following the direction of

the border. Among the artificial borders are the Vertebrate, the Undulating, and the Interlacing; and these are useful as suggestions for the general lines. Plants which have *long* stems or branches are most suitable for Borders. Sometimes the Stem is continuous, as shewn in fig. 27; but it is a better treatment to shew the gradual exhaustion of the branch, as in Nature; and in this latter case to preserve the effect of *continuity* by making the second

branch to commence before the first leaves-off, in order that they may overlap each other.

When continuity is desired and flowers of *short* stems or bunches are used, then the introduction of a spiral ribbon, as in the noble Ghiberti Architrave (though slightly more pronounced than that), will be found useful.

The Distribution should be denser and more regular than in Panels; but it may vary in accordance with some obvious or apparent Law. On comparing the two Borders—fig. 31 (embroidery), and fig. 37 (printed tiles)—it will be observed that in the latter the distribu-

tion is equally dense on both edges, while the former is dense (both in quantity of foliage and in strength of colour) on the inner edge, and sparse on the outer one. This is a good method of emphasizing the function, by increasing the density of the Border towards the edge next to the Panel in the centre.

Repetition is often resorted to; and an example of this is shewn in fig. 37.

§ 33.—FRIEZES.

FRIEZES are never functional; they may, therefore, be as fragmentary, as varied in distribution, and as beautiful as the nature of the Object permits. The surface of the frieze is always *flush* with that of the Framing of the object.

The FRIEZE-ORNAMENT should preserve the sense of the Surface, and never be treated pictorially, so as to lose it; but the semi-pictorial or second degree of Realism is an appropriate treatment, and it should be rich and beautiful. The lines of growth will be generally transverse, *i.e.* upward; or oblique.

There should be no Repetition in friezes.

§ 34.—DIAPERS.

DIAPERS are used for three principal purposes:—

- (i) to give a pleasing Texture, at small expenditure, in places where more important work is not necessary;
- (ii) to disguise Imperfection in material, *e.g.* where the pattern hides flaws in the casting or dropped threads in the weaving, &c.;
- (iii) to disguise the effect of Usage, where the variegated surface makes grease-spots, &c. not so conspicuous as they would be on a plain one.

The effect of a Texture resulting from careful Distribution is therefore desirable.

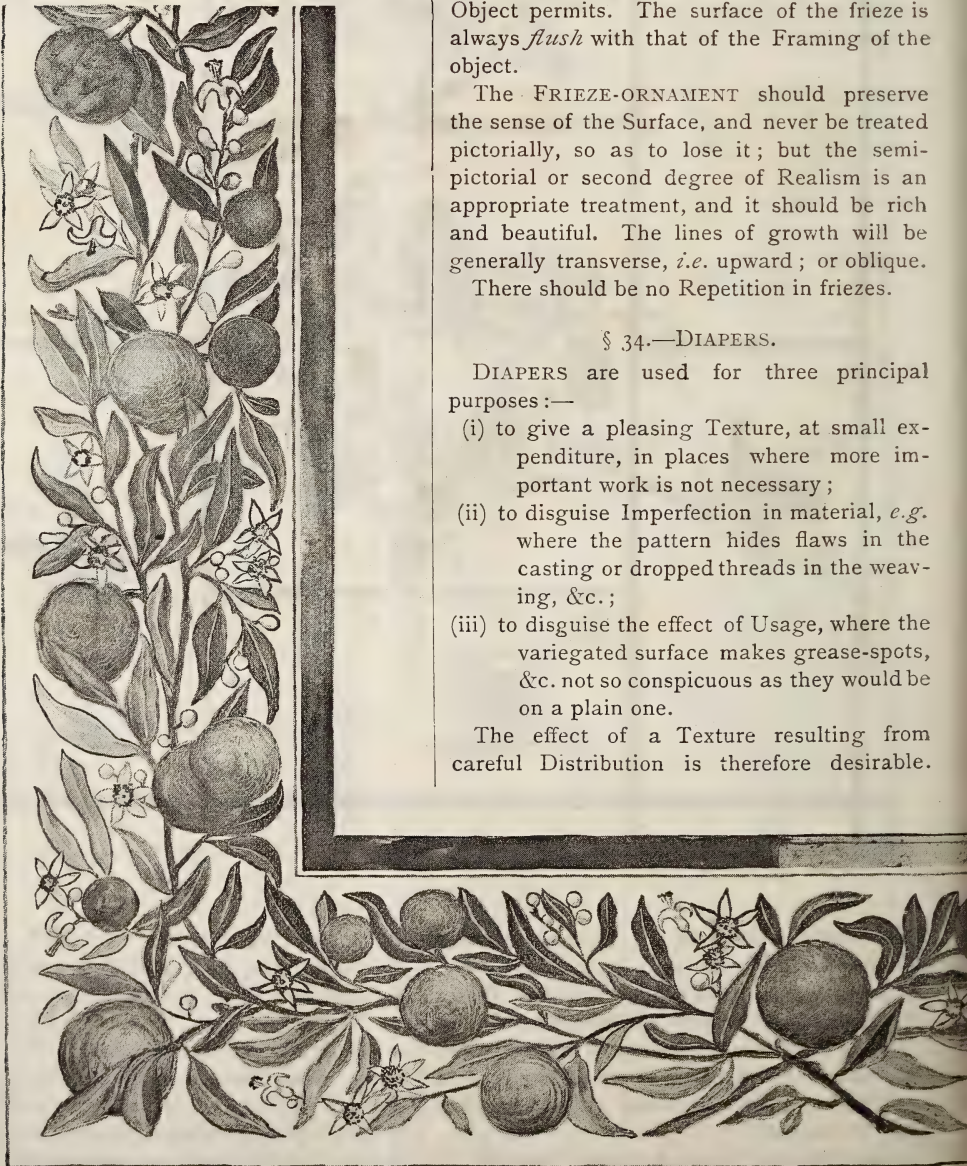


FIG. 31.

There are degrees in this evenness, from the dense distribution of the common Carpet to the sparse distribution of the Brocade silk. But without entering into the Textile question some expedients may be considered.

In applying Plant-form to Diapers the Artist may use *separate* flowers or branches; or *continuous* stems.

SEPARATE BRANCHES may be either *isolated*; or *overlapping*.

ISOLATED BRANCHES may be Powdered either in frankly severe positions, like much mediæval and heraldic work; or in (apparently) irregular positions, like much Japanese work.

SEVERE POWDERING may have the repeating branches drawn in *symmetrical* attitudes

frankly treated. Timidity is a great hindrance in Pattern-work. Several of Messrs. Morris and Co.'s earlier patterns are good examples of frankness in design, *e.g.* their "Daisy" pattern of *severe powdering*, and their "Pomegranate and Lemon" of *balanced powdering*. The patterns in figs. 34 (p. 928) and 15 are other examples of Overlapping Branches; and each is an admirable example of subtle arrangement. They do not shew the stalk-ends as the first three; but—such small omissions are condoned in successful designs.

Generally speaking:—Endogeneous plants, or those which do not ramify, should be treated in the Separate-branch manner.

CONTINUOUS STEMS are generally undulat-



FIG. 32.

(which has, however, been deprecated in § 7), or in *balanced* attitudes, as in the design shewn in fig. 32. Here the stems and leaves are characteristically massed.

IRREGULAR POWDERING is shewn in fig. 33. Here the stems are decidedly straggling; yet they are so arranged as to occupy the space without any overlapping; and, at the same time, to "hide the art".

OVERLAPPING BRANCHES are resorted-to when the Distribution is required to be more dense, as shewn in fig. 13. Here the leaves, &c. of one branch overlap the stem of another; and the result is a well-knit-together and well-covered design.

Each of these three is a type of a good treatment. Whichever be adopted: it should be



FIG. 33.

ing. The general direction of the undulating line may be vertical, *i.e.* running-upward parallel with the breadth of the wall-paper or textile, as in the examples. An undulating line in a general *oblique* direction running-upward toward the L.H., is, however, not so conspicuous, and should be used so far as possible. The treatment, shewn in fig. 20, with *geometrical* undulating stems is to be avoided; and the subtle indeterminate curves of nature are to be sought-out and used, as shewn in figs. 6 and 21.

It might be objected—that all plants shew Exhaustion, and must come to an end; and therefore Continuous Stems are unnatural. The writer hesitates to condemn them, feeling that when artistically hidden the success is

the test; though he would personally prefer patterns which frankly meet the difficulty by using Separate Branches, as shewn in fig. 13.

A TRELLIS EFFECT may be produced by two sets of continuous stems. This will be sparse unless there be a second plant or a second pattern to run-behind and so occupy the interstices of the front or chief pattern; as shewn in fig. 16.

The Stem is too much pronounced in figs. 6 and 21: overlapping with leaves, or a lighter tint for the stems, would reduce the conspicuousness. They are old Wall-paper patterns; and, at the time they were made, it was a common custom to "borrow" Chintz-patterns for Wall-papers or to use a design indiscriminately for either manufacture. The stem is less conspicuous and the whole surface is better covered in fig. 11; and it is therefore a better pattern for a Diaper on a flat and extended surface like a Wall.

What has been said in the *general* rules (see § 20), about covering the stems, is of paramount importance in Diapers. Nature is here our model: the stems are generally inconspicuous in Her handiwork. In Pattern-work the stems are sometimes "there to be found when looked-for", but as often omitted. Many beautiful Oriental Carpet-patterns shew no stem whatever. The stem is often a besetting difficulty; and the Student may often do without it in Diaper-work; but *if* it be used—then it must be *natural*.

Generally speaking:—Exogenous plants, or those which ramify, are best; and a plant which climbs or bends much in a sinuous manner, may be said to "lend itself" to this treatment.

PLANTS OF DIFFERENT KINDS may be used-together in a Diaper, very effectively. They should be very different in character of growth, mass, colour, &c.; the student being careful that they are not incongruous.

If one have a rigid stem, and the other be a trailing plant, or if one be heavy like the Pomegranate, and the other small like the Olive—then a pleasingly varied pattern will result, the smaller detail occupying the interstices of the larger.

THE FLOWERS, being generally conspicuous, are sometimes difficult in Diapers. They should be so arranged in position as to avoid alignment (see § 24); and there should be a sense that they are scattered all-over the ground without being in artificially arranged positions in regard to each-other or to the given shape. A result of Diaper-repetition is that any

particular flower in each repeat will be *plumb* under and over the similar flower in the contiguous repeats of the same file; and will be *level* with the similar flowers in the juxtaposed repeats of the same rank or height. If a second flower were placed *plumb* with, or *level* with the first flower:—it would certainly make vertical or horizontal alignment. Both of these are bad; the latter being the worse; and they should be avoided. Diagonal or oblique alignment, thought not so objectionable, should be avoided, when possible. It will assist the Student to avoid these, if he draw *vertical*, *horizontal*, and *oblique* lines through the first flowers; and then he should carefully avoid these lines in locating the other flowers.

A good method of placing the flowers—is to paint a number of individual flowers, roughly, on loose pieces of paper; and cut them close round to the shapes. These loose flowers may then be moved about experimentally, until the effect is satisfactory; when they may be fixed permanently in their places; and the correct working-drawing made.

LARGE FLOWERS will often spoil the *balance of the diffusion* by their *size*; but this may be obviated by cutting-up their mass, as it is not the *outer size* (to the extreme tips of the petals) but the *weight*, which gives balance. Hence when using large flowers the Student may reduce their weight by opening the petals and shewing wide spaces of the ground between them.

It is impossible to foresee all objectionable treatments; and it would be impracticable to give diagrams illustrating them; but what has been said will, it is hoped, lead the Student to search for these lapses; and to expunge them if found.

§ 35.—TWO METHODS IN DESIGNING DIAPERS.

In designing with ARTIFICIAL FOLIAGE:—the artist begins with a general idea of the *composing lines*.

But in designing with NATURAL FOLIAGE:—he begins by drawing a *branch of the plant*, and he does not attempt to make it follow any lines but those which God designed for it. He makes duplicate drawings of this piece or branch; and he then arranges them at the repeating-distance which is prescribed by the technical necessities of the material. He fills-in the gaps with more nature, if required, considering the placing of the Flowers first.

This method of composing a Diaper by the

arrangement of overlapping duplicates of a study from Nature is more likely to be Natural than the method of making *lines* first, and then clothing them with leaves, &c., because:—

- (i.) there is no predilection or prejudice in favour of one set of lines over another, and the Student is willing to take Nature's line;
- (ii.) the result will be *masses* of foliage rather than *lines* of stems.

§ 36.—INDEFINITE SHAPES AND FORMS.

INDEFINITE SHAPES and FORMS and also those of Irregular or extreme proportion may be easily decorated with natural foliage when the more intractable lines of artificial foliage

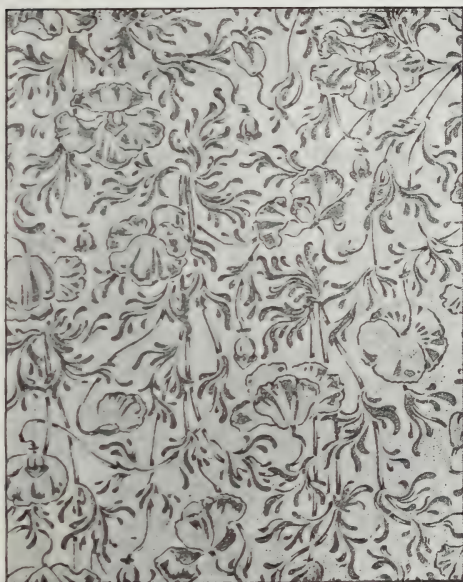


FIG. 34.

could not be applied. An example is given in the perforated panel shewn at fig. 35, in which the foliage pleasingly occupies the spaces around the Initial-letter, and gives Connectedness to the Frame without loss of Clearness.

BODY-ORNAMENTATION is often composed of plant-form with good effect, as may be seen in some beautiful classic Drinking-cups, Bronze-vases, Cinerary-urns, Column-shafts, &c., in various Museums; and on many beautiful Ceramic works seen at Exhibitions. This branch of the subject is, however, more properly dealt-with under the head of Vase-decoration.

FREE ORNAMENTS are often composed of plant-form with good effect. In interior de-

coration natural foliage is often used as a central "Trophy" in a panel, or frieze, or as a cresting Acroterion over a Frame or Cornice, or in combination with a Shield or Tablet encrusted on Mouldings, &c.

The *absence* of any strongly-marked or geometrical curvature which might attract the eye and militate against the architectural lines, the *mass* of leafage which is possible with certain plants, and the *elasticity* with which the stems may be bent to fill odd corners, render natural foliage very valuable; hence its frequent use.

§ 37.—ACCESSORY OBJECTS.

ACCESSORY OBJECTS are occasionally used in connection with natural foliage; for the purpose of giving Logical-commencement, Mass, Line, Colour, Continuity, Distribution, or Contrast.



FIG. 35.

VASES are useful in Panels. The position, at the bottom of panel, holding the branches, gives a Reason for their attitudes, and the Mass is placed where it is most needed. It affords an opportunity for the introduction of any desired colour; and in a succession of panels, with different foliage in each, the similarity of the containing vases gives Unity of effect.

RIBBON is useful in Panels. It ties the branches, and gives the Logical commencement, as shewn in fig. 5. The Lines of the ribbon are often useful for Flow-of-line, and for Contrast to those of the foliage. It gives opportunity for Colour, and thus for Unity. It is also useful in Borders, to give

Unity, and Continuity; as is seen in the Ghiberti architrave. The use of Ribbon, in connection with natural foliage, by the artists of the Quattro and Cinque Cento is well worthy of study by the student; but it would require an entire Lecture; and hence must be passed-over for the present.

TABLETS for inscriptions, and Symbols of various kinds, are used in connection with natural foliage: this, however, belongs to the Didactic branch of the subject.

§ 38.—ANIMALS.

ANIMALS are occasionally used in connection with natural foliage, for the purpose of giving Interest, Colour or Distribution.

SMALL BIRDS and BUTTERFLIES are those that are generally used; and they are applied in Panels only. Their value, in giving points of colour and in occupying spaces of the ground which might otherwise appear vacant, will be seen on referring to fig. 30. The Artist will, of course, introduce those only that frequent the particular plants which are shewn.

§ 39.—VALUE OF NATURAL FOLIAGE.

The study of Natural foliage will enable the Artist to ignore the Historic styles (except as scientific Archæology). These "styles" are so many *ruts* worn by the wheels of our predecessors; but the critic, of the schoolmaster persuasion, would treat them as if *Moats*

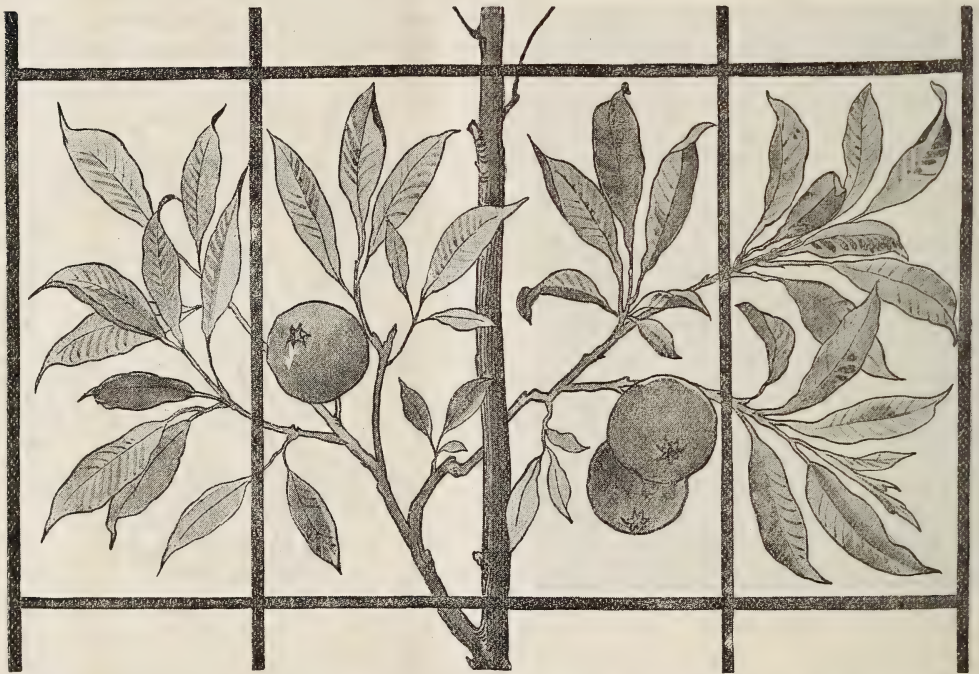


FIG. 36.

from which he, like the Kentaurs in the 7th circle of the Inferno, would rebuke any tendency to rise higher.

The *primary* use of Plant form, *i.e.* as Natural Foliage, has been the attempt of the writer on this occasion: the *secondary* use, *i.e.* as contributory to the building-up of Artificial Foliage (the so-called "Acanthus"), will be dealt-with on another. Then, it will be seen that it will enrich it and re-vivify it from age to age.

It may always be used, as an intermediate feature or "modulating chord", between the Architectural and Pictorial Arts.

It is (when properly treated) the only kind of ornamentation that is permanently pleasing or has been used in all times and places. An instance of its suitability is seen at South Kensington Museum in the borders round the two fine pictures by the President of the Royal Academy. One of these is Greek in *place*, and the V. century B.C. in *date*: the companion is Italian in *place*, and the XIV. century A.D. in *date*. To both of these subjects, so wide apart, no one artificial ornamental pattern (which would necessarily belong to one place and date) could be suitable; but the natural foliage which belongs to *all*



countries and times was suggested by the writer, who had the honour of carrying-it-out.

§ 40.—ON RULES, &c.

The writer does not wish to dogmatise on the subject. The Rules, which have been given, are the result of some experience; but they are only Grammar. There is a grammar of Graphic Representation in all Arts, in which minute rules are laid-down for the guidance of Students; but there is also an enlarged grammar, of Inspired Expression, in each, which the Masters lay-down for themselves.

Rules, as Mr. J. W. Papworth observed, are like the Buoys round shoaly coasts, which may be ignored when the Mariner has learnt to sound the bottom for himself. The Masters in the Arts may appear to ignore rules and produce thereby picturesque Language, picturesque Music, picturesque Architecture, or picturesque Decoration: they are great by reason—not of the broken rules, but—of the Power that is above rules. The Student is therefore advised—not to commence by striving to be picturesque (probably in this he would be only copying the faults of another) but—to choose good grammar and simplicity; and in time, if he have it in him, Originality will be added unto them.

The Rules should not be too apparent: the student must hide his Art. The Spectator should see Natural foliage, and should feel that it decorates the space. (Note that “*see*” is used in the former case, and “*feel*” in the latter; for he should only have an impression that the whole appears decorous; but the means whereby it has been made so, *i.e.* the Art, should be hidden.) “*Ars est celare Artem*”; and if the work appear too artificial: then has the worker failed.



FIG. 37.

§ 41.—

Among those who are known as producing good work in this branch of Applied Art are:—Miss Louisa Aumonier, Professor George Aitchison A.R.A., Messrs. Arthur Brophy, Charles Campbell, Walter Crane R.I., Louis Davis, Owen Davis, Lewis Day, Dr. Christopher Dresser, Miss Kate Falkener, Messrs. George Haité, Edward Hammond, Thomas Hay, Miss Florence Lewis, Messrs. Fredrick Miller, William Morris M.A., William Muckley, George Robinson F.S.A., Arthur Silver, and Charles Voysey.

§ 42.—

The examples have, so far as possible, been taken from Wall-papers rather than from Textile diapers; because the *paper* surface is better for photographic reproduction than the woven one. Acknowledgement is due to the following for the original work reproduced in



FIG. 38.

the figs. as mentioned:—Miss Cole, at South Kensington, fig. 13—Miss E. S. Moore, at S.K., fig. 31—Miss Lambert, at S.K., fig. 37—Mr. Selwyn Image, per School of Art Needlework, fig. 32—Messrs. Campbell and Smith, figs. 30, 36—Messrs. Jeffrey and Co., figs. 33, 34—Messrs. Morris and Co., fig. 15—Messrs. Toleman, fig. 16—Messrs. Wm. Woollams and Co., figs. 6, 11, 12, 17, 21.

Miscellaneous.

THAMES CONSERVANCY.

In this year's report of the Conservators of the River Thames, all that is said referring to sewage pollution is in three paragraphs only, which is in striking contrast to the length it was found necessary to give to the subjects in the reports of many previous years. The history of the steps taken to prevent pollution above the intakes of the Water Companies has been summarised in the *Journal*, and the notices of the reports have been given yearly. The principal statement this year is that the provisions of the Act which relate to the prevention of the discharge of sewage into the river or its tributaries have been enforced. Since all the towns and villages have been compelled to prevent their sewage from passing into

the river, it is the small pollutions that have to be guarded against. As to the sewage works established at various towns, &c., these have been very closely watched, and precautions taken to prevent the possibility of any pollution escaping from them into the river. No legal proceedings have apparently been found necessary. The Conservators' officers also watch house-boats and steam launches with a view to detecting any pollution from these sources.

The difficulties with regard to Staines, which have figured in previous reports, are not over, but "the Conservators," it is stated, "are happy to be able to report that the amount of pollution from the river has, owing to the steps they have taken, been diminished, and there is now reasonable expectation that the remaining pollution will be diverted." Staines has been the last town to comply with the orders of the Conservators, and summonses against individuals have failed in their effect. A number of inhabitants petitioned the Local Government Board to hold an inquiry under the Public Health Act, with a view to compelling the Staines Local Board to provide proper works for the disposal of the sewage of the district under their control.

The Conservators had opposed the Richmond Footbridge, Sluices, Lock, and Slipway Bill, fearing that the works would be detrimental to the river. As, however, the Bill passed, they will themselves carry out the scheme.

In the second part of the report, "Upper Navigation—Staines to Cricklade," reference is made to the additions to the funds from the increased contributions of the water companies, which will enable the Conservators so to improve some of the locks and weirs as to maintain a more equable flow of the water of the river. The report concludes with the statement that the funds are barely sufficient for fulfilling the duties with which Parliament has charged the Conservators.

ORANGE CULTIVATION IN JAPAN.

There are many varieties of the orange found in Japan, of which the most profitable are the *Oonshin*, *Hira Mikan*, *Koji Kinkan*, and *Natsu-Mikan*. In the prefecture of Osaka the location of the orange trees is about three miles distant from the sea, at an elevation of 2,016 feet, and at Oritagun, in the province of Kū, they are located from half a mile to three miles from the sea, at an elevation of 610 to 800 feet. A southerly exposure is the best for the tree, and the best soil a sandy loam, with gravel about 3 feet from the surface. Hilly and undulating land is preferable for the *Oonshin* and *Hira Mikan* varieties. As regards the former, the United States Consul at Hiogo and Osaka says that, in every respect, this is the best variety. The tree, or, more properly speaking, the bush, grows to a height of 10 or 12 feet, and covers a space 22 or 23 feet in

diameter. Its branches close down to the ground, and, not being pruned, the weight of the fruit causes the branches to lie on the ground, completely covering the trunk. They are extremely prolific, and as the fruit is not thinned out when small, it does not often attain a size of over 3 or $3\frac{1}{2}$ inches in diameter, and the majority are not over $2\frac{1}{2}$ in diameter. Like all other fruits, they are packed by the Japanese when green and sour, as early as the 1st of October, and are gathered and packed by December, when they are stored, keeping so well as to be found in the market as late as the end of May. The fruit of the *Oonshin* is flattened at the ends, the rind peels off very easily, and segments part as readily. When the orange is cut horizontally, the juice is so abundant that it runs over freely. They are practically seedless. Out of 200 lately tested, only two were found to have seeds. Their flavour is very pleasant, sweet, and much liked by foreigners in Japan and China. The *Hira-Mikan*, sometimes called *Kishin-Mikan*, or *Kino-Kuni-Mikan*, is a smaller fruit than the *Oonshin*, and, though it has a few seeds, it enjoys a good reputation. The tree grows to a height of 30 feet, is a great bearer, and is as hardy as the *Oonshin*. The *Kinkan*, known in China as the *Cumquat*, or golden orange, grows to the height of 16 feet, and is very prolific. There are two kinds, the *marumi*, or round fruit, and the *nagami*, or long fruit. It contains four or five seeds, and is very palatable, eaten, as it frequently is, with the rind on; but its chief use is as a preserve in syrup or crystalised. It has long been popular, both in China and Japan, when treated in this way. The orange tree is propagated in Japan by grafting on the stalk the *Citrus trifoliata*, or native wild orange, which is so extremely hardy that it does not appear to suffer with cold. It grows to the height of 25 to 30 feet. The fruit is perfectly round, somewhat larger than a billiard ball, and full of seeds. The stock for grafting are propagated from these seeds. The young plants are replanted each spring, and, after two years, are ready for grafting. The leaf is trifoliate, like the clover. The tree is very thorny, and it is deciduous. The sap falls in the winter, and does not rise till late in the spring; and it is to this that the extreme hardness of trees grafted in this stock may be attributed. The Japanese do not appear to give the same attention to the cultivation of orange trees as cultivators in California and Florida do, allowing vegetables and corn to grow between the trees, which are planted so closely together that the branches often interlock. The irrigation which takes place only in the dry season, is effected by pails, and the liquid manure is distributed with ladles. There are no regular orange groves as in the United States, but irregular patches, and many trees are planted on the hill sides in terraces, the same way as rice and other products. No attention is paid to insects beyond burning the cocoons of the chrysalis or beetles. The principal nurseries where the young trees are propagated are about twelve miles from the sea, and

are protected in winter till the third year with coarse straw matting roughly tied round, the idea being to preserve the young growth, and not because injury is feared to the matured branches. As the Japanese see no beauty in an upright tree, but rather prefer them crooked or dwarfed, the young trees are not staked or trained. One reason for preferring the low tree is that they can pick the fruit without the aid of ladders, and another reason is that the branches keep the ground cool and more moist than if exposed to the sun. Consul Smithers says that the market price of the *Oonshin* in Japan is from two to five silver *yen* (the silver *yen* is equivalent to about three shillings and ninepence) per thousand, according to size and quality, and large shipments are made to San Francisco, but owing to their being packed in light boxes, the oranges often arrive in bad and damaged condition.

FOREST AND MINERAL WEALTH OF BRAZIL.

A bulletin lately issued by the Bureau of the American Republics, states that the inexhaustible forests of Brazil abound in woods of great value, some of the most beautiful and valuable being entirely unknown in Europe. The large collection of Brazilian woods exhibited in Philadelphia in 1876 attracted much attention, and the catalogue mentions 22,000 different woods found in the valley of the Amazon alone. The best known of the valuable woods among those of the Amazon are rosewood, satin wood, shell wood—of which latter beautiful shell-like articles are made. The cedars of Brazil are entirely different from the European, and they abound everywhere from north to south. During the floods of the Amazon, they are seen borne along by the current, as a writer on Brazil describes them, "mighty trunks of foliage like floating islands." Among the medicinal plants of the Amazon valley may be mentioned the sarsaparilla, ipecacuanha, the polycarp, the cubeb, the curare—from which the Indians extract the poison for their arrows—the *nuxvomica*, &c. On the Atlantic coast, the variety of valuable woods is continued, and mention may be made of the acapú and angelica and the bacury, which is the building wood most in use in Maranhão. The forests abound in plants producing textile fibres. A firm at Ceará has lately commenced the manufacture of the *gravatá* fibre, a plant belonging to the *bromeliaceae*. The rubber tree exists in several varieties, producing as many different sorts of rubber, and all through the northern regions it thrives well. The once famous Brazil wood, which gave its name to the country, lost its importance with the discovery of the cheaper aniline dyes, and its exportation has dwindled to insignificance. Gutta-percha is produced in Brazil from two species of trees, the jaguá (*Lucuma gigantea*) and the massaranduba

(*Mimusops elata*). The beautiful *vinhatico*, much employed in Brazil for furniture and cabinet work, enjoys a considerable reputation, the greater part of the furniture in Brazil being made either of rosewood or *vinhatico*. The beautiful shaded yellow of this latter makes it remarkable among the woods: at once useful and ornamental. The development of the vast mineral resources of Brazil, with the exception of gold and diamonds, has only just begun. Its deposits of coal and iron, laid bare by scientific explorers, await for the most part the labour and machinery necessary to utilize them. The existence in Brazil has been demonstrated of copper, manganese, and argentiferous lead ore, in considerable quantities, and in widely extended localities. There are also mines of iron, coal, gold, and diamonds. Gold is found in every State in Brazil, and is systematically mined in Minas Geraes, Rio Grande do Sul, Bahia, Matto Grosso, Parana, San Paulo, and Maranhão. Diamonds are co-extensive with the gold deposits, and, like that metal, are most abundant in Minas Geraes, where they have been found since 1789. The most important locality known for the production of these gems is the district of Diamantina, in the above-named State. They are found in Parana, in the gravels of the river Tibagy, and in the bed of streams dry during the summer. Since the discovery of diamonds at the Cape of Good Hope, the Brazilian production has greatly diminished. As regards iron, the State of Minas Geraes abounds with it. It is not found in veins or strata, buried deep in the earth, but in enormous beds, often lying at the surface, or in mountain masses. These vast deposits are worked only by small scattered furnaces, charcoal being used in the reduction of the ore. Of these small furnaces there are five groups, producing about 3,000 tons annually, the product being used in the surrounding districts in the manufacture of articles of home consumption, such as hoes, shovels, picks, drills, nails, horseshoes, &c. In the State of San Paulo are found deposits similar to the best Norwegian ore; and one of the mines is worked by the Government establishment, near the village of Sorocaba. This establishment has two furnaces, and produced in one year about 790 tons of pig iron. The ore has about 67 per cent. of iron. In Santa Caterina, not far from a harbour accessible to the largest vessels, are vast deposits of hematite, containing on an average 30 per cent. of manganese, and 25 to 30 per cent. of iron. In the State of Goyaz, as in Minas Geraes, are found enormous masses of the ore *itaberrite*. The presence of copper has been demonstrated in Rio Grande do Sul, in Matto Grosso, in Minas Geraes and Ceará. The ore has never yet been mined, but in the last named State works have been begun with a view to its extraction and reduction. The ore, as far as yet reached, yields 40 per cent. of copper. The deposits of lead so far discovered are few, but its presence has been determined in Rio Grande do Sul, San Paulo, and Minas Geraes, generally in con-

nection with silver—argentiferous galena—and some times with gold. Bismuth and antimony are found in combination with ores of other metals, but not as yet in considerable quantities. Up to the present, the deposits of coal discovered are not, relatively, so extensive as those of iron, but its presence has been determined in San Paulo where the borings indicated its existence in quantities and situations that render probable a profitable extraction. In Santa Caterina, in the valley of the Tubarão, bituminous coal exists, and a concession has been granted by the Government for working the beds. The State of Rio Grande do Sul appears to be the most favoured in respect to coal deposits. In the Candiota basin, veins of coal crop out, of a thickness varying from four to six feet, but the only mines worked up to the present are those of Arroio dos Ratos, which supply coal to the steamers that ply on the river and to the Government railway. Marbles are abundant and widely distributed; they are of various colours, and resist the disintegrating influences of the climate, under conditions destructive of the marble imported from Europe. In Rio Grande do Sul and San Paulo are various manufactures of works of marble. Important deposits of loadstone are found in Minas Geraes. In the State of Goyaz, in the Sierra dos Cristaes (Crystal Range), are found in abundance the well-known "Brazilian pebbles," whose pure quartz is employed in the manufacture of lenses and spectacles. They are found near the surface, usually covered with a coating of iron oxide. In the calcareous caverns of the San Francisco plateau and of the river Velhas, in Minas Geraes, saltpetre has for a long time been collected. One of these grottoes, near Diamantina, furnished within a few days after its discovery forty tons of the pure crystals. Graphite is also found in considerable quantities in Minas Geraes, one of the deposits yielding 83 per cent. of carbon suitable for pencils.

General Notes.

COAL IN BELGIUM.—The extraction of coal in Belgium, in the first half of 1891, was 9,094,389 tons. The imports of coal into Belgium in the same period were 789,971 tons, while those of coke were 60,705 tons—equivalent to 80,940 tons of coal—making an aggregate of 9,955,300 tons. The stocks of coal on hand in Belgium at the close of the half-year were estimated at 481,945 tons. The exports of coal from Belgium, in the first half of this year, were 2,074,946 tons, while those of coke were 482,418 tons, equivalent to 643,759 tons of coal. These deductions, taken together, amount to 3,200,648 tons, leaving the consumption of coal in Belgium, in the first half of this year, at 6,764,652 tons.

Journal of the Society of Arts.

No. 2,034. VOL. XXXIX.

FRIDAY, NOVEMBER 13, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirty-eighth Session of the Society will be held on Wednesday, the 18th November, when the Opening Address will be delivered by the ATTORNEY-GENERAL, M.P., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

ORDINARY MEETINGS.

NOVEMBER 18.—Opening Address by the ATTORNEY-GENERAL, M.P., Chairman of the Council.

NOVEMBER 25.—PROF. SILVANUS P. THOMPSON, F.R.S., "Measurement of Lenses."

DECEMBER 2.—G. H. ROBERTSON, F.C.S., Assoc. Inst. El. Eng., "Secondary Batteries." W. H. PREECE, F.R.S., will preside.

DECEMBER 9.—JAMES DREDGE, "The World's Fair at Chicago, 1893." THE ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

DECEMBER 16.—PROF. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention."

Papers for which no dates have yet been fixed:—

"The Scientific Value of Lovibond's Tintometer." By F. W. EDGRIDGE-GREEN, M.D.

"Burning Oils for Lighthouses and Lightships." By E. PRICE EDWARDS.

"Dust, and How to Shut it Out." By T. PRIDGIN TEALE.

"Typological Museums." By GENERAL PITT RIVERS.

"Iceland." By T. ANDERSON.

"The Woodcuts of Gothic Books." By WILLIAM MORRIS, M.A.

"Artistic Treatment of Jewellery and Personal Ornament." By T. W. TONKS.

"Agricultural Banks for India." By Sir WILLIAM WEDDERBURN, Bart.

"The Agricultural Needs of India." By Dr. J. AUGUSTUS VOELCKER.

"Travels in Indo-China." By LORD LAMINGTON.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at Half-past Four o'clock:—

January 19, February 16, March 15, April 5, 26, May 24.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday afternoons, at Half-past Four o'clock:—

January 21, February 11, March 3, 24, April 28, May 19.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 26, February 23, March 8, 29, April 12, May 17.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock:—

A. P. LAURIE, M.A., "The Pigments and Vehicles of the Old Masters." Three Lectures.

LECTURE I.—NOVEMBER 30.—A brief account of fresco painting as described by Cennino Cennini, and of the preparation of panels, gesso work and gilding, in the 15th century. Also a description of the preparation of gilt Spanish leather.

LECTURE II.—DECEMBER 7.—The pigments used in the 15th century, and their preparation and properties, with some account of the methods of painting.

LECTURE III.—DECEMBER 14.—The mediums used by the Old Masters, in tempera and oil painting. The preparation of the oils and varnishes, and the properties of the same.

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.

January 25, February 1, 8, 15.

PROF. WILLIAM ROBINSON, M.E., Assoc. M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.

February 29, March 7, 14, 21.

BENNETT H. BROUGH, "Mine Surveying."

Three Lectures.

March 28, April, 4, 11.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bacteriology of the Fermentation Industries."

Four Lectures.

May 2, 9, 16, 23.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday evenings, at Eight o'clock, by PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

February 5, 12, 19, 26, March 4, 11.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, January 6 and 13, 1892, at 7 p.m.

EXAMINATIONS.

Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

Chicago Exhibition, 1893.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

The Royal Commission are now prepared to receive applications from manufacturers and others desirous of taking part in the Exhibition.

Such applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, not later than February 29th, 1892, and addressed to the Secretary, as above.

A prospectus giving particulars of charges for space and further information can be obtained at the Society's offices,

MUSICAL CONGRESS.

Arrangements have been made for the exhibition of the art of music in all its varieties, and the Committee appointed to consider the matter has proposed that a series of Congresses shall be arranged, with the object of bringing together as many as possible of the leaders in musical achievement of every kind, including composers, artists, teachers, theorists, savants, and musical journalists. The Committee has issued a classification. Class A includes Instrumental, and Vocal Music. Class B, the History and Theory of Music, Musical Education, Acoustics, &c.

Miscellaneous.

BULGARIAN EXHIBITION, 1892.

Information has been received from the Foreign-office, through the Science and Art Department, respecting an Agricultural and Industrial Exhibition to be held at Plovdiv (Philippopolis) from the 6th (18) September, 1892, to the 31st October (12th November). The authorities are anxious that British manufacturers should take part in the Exhibition. The classes to which foreigners can contribute consist of machines and appliances for Agriculture and Rural Economy, Industrial Machinery in general, and Works treating of Agriculture, Forestry, Rural Economy, and Public Industries, Atlas, Models, &c. Applications for space must be made to the Exhibition Committee at Sofia before the end of the present year. In connection with the above, an Agricultural Exhibition will also be held at Roustchouk from the 2nd (14th) August to the 30th September (12th October), 1893. The same classes of objects can be exhibited by foreigners at this Exhibition as at the one held at Philippopolis. Copies of application forms have been received, and can be obtained on application to the Secretary of the Society of Arts.

MADRID AMERICAN EXHIBITION.

In connection with information relating to the Historical American Exhibition, to be held at Madrid in 1892, to commemorate the fourth centenary of the discovery of America by Columbus in 1492, which was printed in the *Journal* for September 25th last (see *ante* p. 842), particulars of a Fine Art Exhibition have been received from the Foreign-office through the Science and Art Department. A Royal Decree was issued by the Queen Regent of Spain on October 4th, 1891, to the effect "That the National Exhibition of Fine Arts which, according to the provisions of the regulations approved by the Royal Decree of the

29th August, 1889, ought to be held during the month of May next, shall take place instead in an international form, in the month of September of the same year."

The Exhibition will be held at Madrid in connection with the American Exhibition, and will be open from the 15th September to the 15th November. There will be sections for Painting, Sculpture and Architecture, and an International Hanging and Judging Committee will be elected.

Each exhibitor may submit any number of works in each section, and the days of reception will be in August, 1892.

The following will be excluded from exhibition:—

1. Works which have competed for a prize in former National Exhibitions.
2. Copies, with the exception of those which reproduce a work in a distinct form, such an engraving or drawing from an oil painting, clay reproduced in marble or bronze.
3. Photographs.
4. Pictures whose frames are painted in such a manner as not to harmonise with the rest, or which cannot be hung in accordance with the opinion of the Committee.
5. Anonymous works.

General Notes.

CHICAGO EXHIBITION, 1893.—FOREIGN APPROPRIATIONS.—The following list has been issued of the nations and colonies who intend to participate in the Exhibition, with the amounts of the appropriations officially announced:—Great Britain, £25,000; British Guiana, £3,000; British Honduras, £1,400; Cape Colony, £2,000; Trinidad, £2,000; Guatemala, £24,000; Honduras, £4,000; Argentine Republic, £20,000; Austria - Hungary, £33,600; Bolivia, £20,000; Brazil, £110,000; Chili, £20,000; Columbia, £20,000; Costa Rica, £10,000; Danish West Indies, £2,000; Ecuador, £25,000; France, £80,000; Germany, £50,000; Japan, £100,000; Mexico, £150,000; Nicaragua, £4,000; Peru, £20,000; Salvador, £6,000; Cuba, £5,000.

CAPE RAILWAYS.—The traffic earnings on Cape Government railways during the month of June, 1891, amounted to £157,435, as compared with £158,394 for the corresponding period in 1890. For the six months ended June, 1891, the total traffic earnings were £918,079, as against £1,051,165 for the corresponding six months of last year.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOV. 16...British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. Favargar, "Modern Egyptian Buildings."

London Institution, Finsbury-circus, E.C., 5 p.m. Right Hon. Sir M. E. Grant-Duff, "Some of our Debts to the East."

TUESDAY, NOV. 17...Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. H. K. Bamber, "Portland Cement: its Manufacture, Use, and Testing." 2. Mr. A. E. Carey, "The Inspection of Portland Cement for Public Works." 3. Mr. William Smith, "The Influence of Sea-water upon Portland Cement Mortar and Concrete."

Statistical, School of Mines, Jermyn-street, S.W., 7½ p.m. Inaugural Address by the President, Dr. F. J. Mouat, LL.D.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. A. Boulenger, "A Synopsis of the Tadpoles of the European Batrachians." 2. Mr. Edgar A. Smith, "Descriptions of New Species of Shells from New South Wales, New Guinea, the Caroline and Solomon Islands." 3. M. E. Simon, "The Spiders of the Island of St. Vincent." 4. Mr. H. Nevill, "The Importance of an Experimental Zoological Station in the Tropics."

WEDNESDAY NOV. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Address of the 138th Session by the Attorney-General, M.P., Chairman of the Council.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Robert H. Scott, "Report on the International Meteorological Conference at Munich, September, 1891." 2. Mr. W. J. E. Binnie, "A New Self-Recording Rain Gauge." 3. Prof. J. D. Everett, "Wet and Dry Bulb Formulæ." 4. Mr. Frank Russell, "Results of Meteorological Observations made at Akassa, Niger Territories, May, 1889, to December, 1890."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Special Meeting to consider New Bye-laws. 2. Mr. A. W. Bennett, "Fresh-water Algæ of South-West Surrey."

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. Opening Address by the Chairman.

THURSDAY, NOV. 19...Linnean, Burlington-house, W., 8 p.m.

1. Mr. W. Carruthers, "Notes on the Original Portraits of Linnæus made during a recent visit to Sweden." 2. Mr. Thos. Hick, "A new Fossil Plant from the Lower Coal Measures."

Chemical, Burlington-house, W., 8 p.m. Capt. W. de W. Abney, "Colour Photometry."

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Dr. Dallinger, "Spiders: their Work and their Wisdom."

Historical, 20, Hanover-square, W., 8½ p.m. Mr. C. W. C. Oman, "Some Points in the Πολιτεία τῶν Ἀθηναίων."

FRIDAY, NOV. 20...Physical, Science Schools, South Kensington, S.W. Dr. C. V. Burton, "A New Theory concerning the Constitution of Matter."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals.

TRANSACTIONS, &c.

- American Academy of Arts and Sciences, Proceedings and Memoirs.
 American Chemical Society, Journal.
 American Institute of Electrical Engineers, Transactions.
 American Philosophical Society, Proceedings.
 American Society of Civil Engineers, Transactions.
 Association of Engineering Societies, Journal.
 Bath and West of England Society, Journal.
 Berlin, Polytechnische Gesellschaft, Polytechnisches Centralblatt.
 Birmingham Philosophical Society, Proceedings.
 British Association for the Advancement of Science, Report.
 British Guiana, Royal Agricultural and Commercial Society of, Journal.
 British Horological Institute, Horological Journal.
 Camera Club, Journal.
 Canada, Royal Society of, Proceedings and Transactions.
 Canadian Institute, Proceedings.
 Central Chamber of Agriculture, Proceedings.
 Chemical Society, Journal.
 Cleveland Institution of Engineers, Proceedings.
 County of Middlesex Natural History and Science Society, Transactions.
 Doubs, Société d'Emulation du, Mémoires.
 East India Association, Journal.
 Farmers' Club, Journal.
 Franklin Institute, Journal.
 Geological Society, Quarterly Journal.
 Geologists' Association, Proceedings.
 Glasgow Philosophical Society, Proceedings.
 Incorporated Gas Institute, Transactions.
 India, Geological Survey of, Memoirs, Records and Palæontologia Indica.
 Indian Meteorological Memoirs.
 Institute of Bankers, Journal.
 Institute of Patent Agents, Transactions.
 Institution of Civil Engineers, Minutes of Proceedings.
 Institution of Civil Engineers of Ireland, Transactions.
 Institution of Electrical Engineers, Journal.
 Institution of Engineers and Shipbuilders in Scotland, Transactions.
 Institution of Mechanical Engineers, Proceedings.
 Institution of Naval Architects, Transactions.
 Iron and Steel Institute, Journal.
 Japan, College of Science, Imperial University, Journal.
 Junior Engineering Society, Publications.
 Kew Gardens Bulletin.
 Linnæan Society, Journal.
 Liverpool Literary and Philosophical Society, Proceedings.
 Liverpool Polytechnic Society, Journal.
 London Association of Foremen Engineers and Draughtsmen, Publications.
 London Chamber of Commerce, Journal.
 Lyon, Société des Sciences Industrielles, Annales.
 Manchester Literary and Philosophical Society, Memoirs and Proceedings.
 Manitoba Historical and Scientific Society, Transactions.
 Mauritius, Société Royale des Arts et des Sciences, Transactions.
 Munich, Polytechnischer-Verein, Bayerisches Industrie-und-Gewerbeblatt.
 National Indian Association, "The Indian Magazine."
 Nederlandsche Maatschappij ter Bevordering van Nijverheid, Tijdschrift.
 North-East Coast Institution of Engineers and Shipbuilders, Transactions.
 Nova Scotian Institute of Natural Science, Proceedings and Transactions.
 Patent-office, The Illustrated Official Journal.
 Pharmaceutical Society, Journal and Transactions.
 Philadelphia, Academy of Natural Sciences, Proceedings.
 ———, Engineers' Club of, Proceedings.
 Photographic Society of Great Britain, Journal.
 Physical Society of London, Proceedings.
 Quekett Microscopical Club, Journal.
 Royal Agricultural Society, Journal.
 Royal Astronomical Society, Memoirs.
 Royal Colonial Institute, Proceedings.
 Royal Cornwall Polytechnic Society, Annual Report.
 Royal Geographical Society, Proceedings and Journal.
 Royal Geological Society of Ireland, Journal.
 Royal Historical and Archaeological Association of Ireland, Journal.
 Royal Institute of British Architects, Journal of Proceedings and Transactions.
 Royal Institution of Great Britain, Proceedings.
 Royal Irish Academy, Transactions and Proceedings.
 Royal Meteorological Society, Quarterly Journal.
 Royal National Life Boat Institution, "The Life Boat."

Royal Scottish Society of Arts, Transactions.
 Royal Society, Philosophical Transactions and Proceedings.
 Royal Society of Edinburgh, Transactions and Proceedings.
 Royal Statistical Society, Journal.
 Royal United Service Institution, Journal.
 Schlesische Gesellschaft für vaterländische Cultur, Jahres Bericht.
 Société d'Encouragement pour l'Industrie Nationale, Bulletin.
 Société Internationale des Electriciens, Bulletin.
 Société Nationale d'Acclimatation de France, Revue.
 Society of Antiquaries, Archæologia and Proceedings.
 Society of Architects, Proceedings.
 Society of Biblical Archæology, Transactions and Proceedings.
 Society of Chemical Industry, Journal.
 Society of Cymmrodorion, Magazine.
 Society of Dyers and Colourists, Journal.
 Society of Engineers, Transactions.
 Society of Public Analysts, "The Analyst."
 South Wales Institute of Engineers, Proceedings.
 Tasmania, Royal Society of, Papers and Proceedings.
 Victoria Institute, Journal of the Transactions.
 Württemberg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.
 Zoological Society, Proceedings and Transactions.

PERIODICALS.

Twice a Week.

Chemiker-Zeitung.

Weekly.

Accountant.
 Amateur Photographer.
 American Gas Light Journal.
 American Architect and Building News.
 American Manufacturer and Iron World.
 Architect.
 Architecture and Building (New York).
 Athenæum.
 Bradstreet's.
 Breweries and Distilleries.
 British Architect.
 British Journal of Photography.
 Builder.
 Builders' Weekly Reporter.
 Building News.
 Chemical News.
 Chemist and Druggist.
 Civil Service Competitor.
 Colliery Guardian.
 Colonies and India.
 Cosmos ; Revue des Sciences.
 Electrical Engineer.
 Electrician.
 Electricité.
 Engineer.
 Engineering.

Engineering Record (New York).
 English Mechanic.
 European Mail.
 Farmer and Stock Breeder.
 Gardeners' Chronicle.
 Gardening World.
 Herapath's Railway Journal.
 Indian Engineering.
 Industries.
 Invention.
 Iron.
 Ironmonger.
 Jewelers' Weekly (New York).
 Journal of Gas Lighting.
 Journal d'Hygiène.
 Journal des Mines.
 Land and Water.
 Medical Press and Circular.
 Metropolitan Local Government Journal.
 Miller.
 Millers' Gazette.
 Mining Journal.
 Moniteur Industriel.
 Musical Standard.
 Nature.
 Perak Government Gazette.
 Photographic News.
 Pottery and Glassware Reporter (Pittsburgh).
 Practical Engineer.
 Produce Markets' Review.
 Publishers' Circular.
 Queen.
 Revue Industrielle.
 School Board Chronicle.
 Schoolmaster.
 Science (New York).
 Scientific American.
 Statist.
 Telegraphic Journal and Electrical Review.
 Textile Mercury.
 Warehousemen and Drapers' Trade Journal.

Fortnightly.

Anthony's Photographic Bulletin.
 Brewers' Guardian.
 Corps Gras Industriels.
 Country Brewers' Gazette.
 Finance Chronicle.
 Gaceta Industrial.
 Ingeniero y Ferretero Espanol y Sud-Americano.
 Irish Builder.
 Jeweller and Metalworker.
 Moniteur des Produits Chimiques.
 Planters' Gazette.

Monthly.

Art Journal.
 Bookseller.
 Brewers' Journal.
 British Bookmaker.
 British Trade Journal.

Building Societies' Gazette.
 Building World.
 Cabinet Maker and Art Furnisher.
 Camera.
 Canadian Patent Office Record.
 Caterer and Refreshment Contractors' Gazette.
 Cigar and Tobacco World.
 Confectioners' Union.
 Dental Record.
 Drinks.
 Dyer and Calico Printer.
 Educational Times.
 Electrical Plant.
 Engineering Magazine (New York).
 Furniture Gazette.
 Furniture and Decoration.
 Giornale del Genio Civile.
 Greater Britain.
 Hardware Trade Journal.
 Inland Architect (Chicago).
 Irish Textile Journal.
 Ironmongery.
 Journal of Decorative Art.
 Leather Trades' Circular.
 Machinery Market.
 Manufacturer and Inventor.
 Manufacturers' Review and Industrial Record.
 Marine Engineer.
 Midland Naturalist.
 Mineral Water Trade Review and Guardian.
 Monde de la Science et de l'Industrie.
 Moniteur Scientifique.
 Musical Times.
 Nautical Magazine.
 Oestereichische Monatsschrift für den Orient.
 Paper Maker.
 Paper Makers' Monthly Trade Journal.
 Plumber and Decorator.
 Pottery Gazette.

Propriété Industrielle.
 Publication Industrielle d'Armengand Aîné. Revue illustrée, des Machines, Appareils et Procédés.
 Railway Press.
 Saddlers, Harness Makers, and Carriage Builders' Gazette.
 Sanitary Record.
 Sugar Cane.
 Specialities.
 Symons's Monthly Meteorological Magazine.
 Textile Recorder.
 Ulster Agriculturist.
 Watchmaker, Jeweller, and Silversmith.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

Quarterly.

Technology Quarterly (Boston, Mass.).

NEWSPAPERS.

Belgian News.
 Bombay Gazette (Overland Summary).
 Ceylon Observer (Overland Edition).
 Daily Inter Ocean (Chicago).
 Eastern Post.
 Empire.
 Home and Colonial Mail.
 London Commercial Record.
 London and China Telegraph.
 Newcastle Weekly Chronicle.
 Nottinghamshire Guardian.
 Sheffield and Rotherham Independent.
 South African Empire.
 Times of Ceylon (Weekly Summary).
 Times of India (Overland Weekly Edition).
 West London Observer.
 Westminster and Lambeth Gazette.

INDEX TO VOL. XXXIX.

A.

- Abel, Sir Frederick, K.C.B., Albert medal awarded to, 657; presented to, by H.R.H. the Prince of Wales, 739
- Abercorn, Duke of, C.B., *chair*, proposed Irish channel tunnel, 235
- Abney, Capt. W. de W., C.B., F.R.S., *chair*, photography in aniline colours, 150; *Popular afternoon lectures*, science of colour, 249, 269, 281, 315, 331; report of council, 680
- Africa, chartered companies in, *paper* by Commander V. Lovett Cameron, C.B., 249
- Agricultural and mineral development of Colorado, 884
- colonies in Venezuela, 652
- credit institutions in Austria, 849
- industry in Asiatic Russia, 807; in Russia, 832
- products of Madagascar, 748
- Agriculture and live stock in the Argentine republic, 17
- Albert medal, list of awards, 281, 315: awarded to Sir Frederick Abel, K.C.B., 657; report of council, 680; presentation by H.R.H. the Prince of Wales to W. H. Perkin, F.R.S., and Sir Frederick Abel, F.R.S., 739
- Alligators' teeth, 247
- Aluminium in steel ingots, 774
- America (*see* "United States.")
- American tinned fruit, 78
- American (Spanish) trade, development of, 725
- Aniline colours, photography in, *paper* by A. G. Green, C. F. Cross, and E. J. Bevan, 150
- Annam, forests of, 16
- APPLIED ART SECTION:—Meeting of the committee, 51; report of council, 679
- 1st Meeting:—"Lithography; a finished chapter in the history of illustrative art," by William Simpson, 189
- 2nd Meeting:—"Sgraffito," by Heywood Sumner, 229
- 3rd Meeting:—"Enamels and enamelling," by J. Starkie Gardner, 331
- 4th Meeting:—"The use of cloisonné for decoration in ancient and modern times," by Clement Heaton, 375
- 5th Meeting:—"Decorative plaster-work: modelled stucco-work," by G. T. Robinson, F.S.A., 439
- 6th Meeting:—"Glass painting," by H. Arthur Kennedy, 591
- Argentine republic, agriculture and live stock in, 17; beer production and consumption in the, 651
- Armenia and its people, *paper* by Capt. J. Buchan Telfer, R.N., 567
- Armstrong, T., *chair*, decorative plaster-work: modelled stucco-work, 439
- Asbestos in New South Wales, 606; mining in Canada, 854
- Attorney-General, M.P., Q.C., opening address as chairman of council, 6; *chair*, Chicago exhibition, 31; *chair*, methods and processes of the ordnance survey, 257; re-elected chairman of council, 687
- Australia (Western), mining in, 86
- Austria, agricultural credit institutions in, 849; forestry in, 858

- Austro-Hungarian railways and the zone system, 843
- Aumonier, F., *letter*, fast and fugitive dyes, 566
- Aumonier, W., *disc.*, glass-painting, 603

B.

- Bahamas, fibre-cleaning machines in the, 913
- Bailey, F., *paper*, electric lighting progress in London, 51
- Banana production in tropical countries, 519
- Barley culture in France, 15
- Barnaby, Sydney, *disc.*, steam lifeboats, 136
- Barrett, William Alexander, *obituary*, 914
- Barry, Charles, *chair*, sgraffito, 229
- Barton, James, *disc.*, the proposed Irish channel tunnel, 240
- Bayley, Sir Steuart Colvin, K.C.S.I., *chair*, Indian village communities, 403
- Beer production and consumption in the Argentine republic, 651
- Belgium, coal in, 934
- Bernard, Sir Charles, K.C.S.I., *disc.*, hall-marking of silver plate, 170; *chair*, economic development of Siam, 282
- Bevan, E. J., A. G. Green, and C. F. Cross, *paper*, photography in aniline colours, 150; silver medal awarded to them, 657
- Bimetallism, *paper* by Sir Guilford Molesworth, K.C.I.E., 456
- Birdwood, Sir George, K.C.I.E., *disc.*, hall-marking of silver plate, 167; *disc.*, history and description of the growing uses of Tussur silk, 648; annual meeting, 686; *letters*, tughra of the Sultans of Turkey, 809, 846, 867
- Black, Dr., *disc.*, physical tests in competitive examinations, 26
- Blackburn, Henry, *disc.*, illustrated journalism, 184
- BOOKS, NOTES ON:—
- Abney, Captain, colour measurement and mixture, 698
- Beaumont, R., colour in woven design, 139
- Buchan, W. P., ventilation, 726
- Catalogue of the science library in the South Kensington Museum, 589
- Coghlan, G. A., wealth and progress of New South Wales, 590
- Euclid's geometry, by A. E. Layng, 114
- Earl, A. G., laboratory work, 92
- Finch, J., to South Africa and back, 29
- Fry, Herbert, London illustrated, 698
- Greenwood, T., public libraries, 29
- Hassell, J., familiar objects of everyday life, 726
- Keltie, J. Scott, applied geography, 80
- Kew reports, 29
- Lipperheide, F., die decorative kunst-stickerei, 29; musterblatte für kunstlerische handarbeiten, 29
- Murché, V. T., text-book of physiology, 726
- Moffatt's new geography, 726
- Wright, Dr. C. R. Alder, threshold of science, 28
- Wright, Lewis, optical projection, 521
- Borax, sources and applications of, *paper* by E. L. Fleming, 524

Botly, W., *disc.*, hall-marking of silver plate, 170
 Braddon, Sir Edward N. C., K.C.M.G., *paper*, recent development of Tasmanian industries and prosperity, 363; silver medal awarded to, 657
 Bramwell, Sir Frederick, Bart., F.R.S., *disc.*, opening meeting, 14; *disc.*, Chicago exhibition, 47; *chair*, electric lighting progress in London, 51; *chair*, modern flour milling, 298; *chair*, annual general meeting, 675; elected deputy chairman of council, 687
 Brandreth, A., *disc.*, Indian village communities, 417
 Brazil, forest and mineral wealth of, 933
 Bridges, L., *letter*, decorative plaster work, 565
 Brooks, F. Vincent, *disc.*, lithography, 199
 Bruce, Mr. *disc.*, electricity in relation to the human body, 323
 Brunton, R. Henry, *letter*, decorative plaster-work, 520
 Budapest exhibition of earthenware, 227, 328
 Bulgaria, foreign trade of, 28
 Bulgarian exhibition, 936

C.

Calendar for session 1890-91, 4
 California, wine industry of, 653
 Cameron, Commander V. Lovett, C.B., *paper*, chartered companies in Africa, 249
 Canada, asbestos mining in, 854
 Canadian egg trade, 834

CANTOR LECTURES:—

Report of council, 679

1st Course:—"Gaseous illuminants," by Prof. Vivian B. Lewes, 81, 94, 106, 117, 141; *syllabus*, 2

2nd Course:—"The construction and capabilities of musical instruments," by A. J. Hipkins, 739, 751, 763; *syllabus*, 139

3rd Course:—"The electric transmission of power," by Gisbert Kapp, 687, 699, 711; *syllabus*, 228

4th Course:—"Photographic chemistry," by Prof. R. Meldola, 787, 799, 812; *syllabus*, 279

5th Course:—"The decorative treatment of natural foliage," by Hugh Stannus, F.R.I.B.A., 859, 874, 905, 917; *syllabus*, 402

Cape of Good Hope railways, 937

Carpet weaving in Persia, 731

Carpmael, Alfred, *disc.*, decimal coinage, weights, and measures, 225

Carteighe, Michael, annual meeting, 686

Carter, J. Harrison, *paper*, modern flour milling, 299

Catechu (pale) or katha, 156

Ceramics in Denmark, 277

Chaplin, Mr., *disc.*, electric lighting progress in London, 62

Cheesewright, F. H., *paper*, harbours, natural and artificial, 345

Chemistry (photographic), *Cantor lectures* by R. Meldola, 787, 799, 812; *syllabus*, 279

Chetwynd, Capt. the Hon. H. W., R.N., *disc.*, steam lifeboats, 135

CHICAGO EXHIBITION, 1893:—

The Chicago international exhibition of 1893, *paper* by J. Dredge, 32; *letter* F. W. Fletcher, 63

Notices, 80, 115, 328, 361

Plans of buildings, 87, 897

Classification, 361

Notice of appointment of the council of the Society of Arts as a Royal Commission, 711

Council meeting to receive members of United States Commission, 717

Report on exhibition buildings, by Alan Johnstone, 727

United States Labour Law, 731

Warrant appointing the council a Royal Commission, 799

Rules and regulations of the department of fine arts, 811
 United States Government regulations governing the free importation of articles for exhibition, 823

General regulations for foreign exhibitors, 825

Bristol at the exhibition, 847

Extracts from *The Times* articles on Chicago and its exhibition, 871, 904

Meetings of the Royal Commission, 887, 916

Report of James Dredge and Sir H. Trueman Wood, 887

Department of live stock, 916

Finances of the exhibition, 902

Information respecting applications for space, 903, 916

Musical congress, 936

Foreign appropriations, 937

Chili, industrial condition of, 158

China, some vicissitudes in the story of, *paper* by Sir Thomas Wade, G.C.M.G., K.C.B., 475

Chitty, G., *disc.*, modern flour milling, 310

Churchill, Lord Alfred S., *chair*, harbours, natural and artificial, 345

Cider and wine production in France, 265

Citron (sacred), of Morocco, 821

Clarke, C. Purdon, C.S.I., *disc.*, hall-marking of silver plate, 171

Clarke, Hyde, *disc.*, chartered companies in Africa, 256; *disc.*, economic development of Siam, 297; *letter*, Indian village communities, 420; *disc.*, Periar irrigation project, 565; *disc.*, Armenia and its people, 585; *letter*, Tussur silk, 674; annual meeting, 686; *letter*, tughra of the Sultans of Turkey, 822

Cloisonné, use of, for decoration in ancient and modern times, *paper* by Clement Heaton, 375

Coal production of India, 726; of the United States, 885; of Belgium, 934

Coalfields of the Northern Shan States, 588

Cobb, Francis, *chair*, impressionism in photography, 65; *chair*, recent development of Tasmanian industries and prosperity, 363; *disc.*, some vicissitudes in the story of China, 490

Codfish, curing, in France, 773

Cod fisheries of Lofoden, 738

Coinage, decimal, weights, and measures, *paper* by J. E. Dowson, 201; *letter*, Dr. W. W. Hardwicke, 245

Cole, Alan S., *letter*, sgraffito, 267

Cole, Mr., *disc.*, uses of petroleum in prime motors, 518

Colomb, Admiral, *disc.*, physical tests in competitive examinations, 26

Colombia, railways of, 138

Colonisation and its limitations, *paper* by E. J. Ravenstein, 269

Colorado, agricultural and mineral development of, 884

Colour, science of, *Popular afternoon lectures* by Capt. Abney, C.B., F.R.S., 249, 269, 281, 315, 331; standard of, report of council, 684

Colour tests of the Board of Trade, 851

Commerce, Phœnician, 698

Commercial museum at Constantinople, 674

COMMITTEES:—
 Applied art section, 51

Foreign and colonial section, 51, 249

Indian section, 31, 249

Constantinople commercial museum, 674

Conversazione, 657; report of council, 684

Corbett, J., *disc.*, steam lifeboats, 135

Cork, applications of, 845; industry in Spain, 77

Cotton, General Sir Arthur, K.C.S.I., *letter*, Periar irrigation project, 589

Council, 1890-91, 1; report of, 676; 1891-92, elected, 686; report of council, 684; Attorney-General elected chairman, 687; Sir Frederick Bramwell elected deputy chairman, 687

—, thanks to J. Dredge for his paper on the Chicago exhibition, 657

Crompton, R.E., *disc.*, electric lighting progress in London, 60

Cross, C. F., *disc.*, fast and fugitive dyes, 550

Cross, C. F., A. G. Green, and A. J. Bevan, *paper*, photography in aniline colours, 150; silver medal awarded to them, 657
 Cunliffe-Owen, Sir Philip, K.C.B., K.C.M.G., C.I.E., *disc.*, history and description of the growing uses of Tussur silk, 650

D.

Dallmeyer, T. R., *disc.*, impressionism in photography, 74; *disc.*, photography in aniline colours, 155
 Danvers, F. C., silver medal presented to, 13; *disc.*, study of Indian history, 669
 Davis, H. J., *disc.*, modern flour milling, 310
 Davison, G., *paper*, impressionism in photography, 65
 Day, Lewis F., *disc.*, lithography, 199; *disc.*, use of cloisonné for decoration, 338; *chair*, glass painting, 591; *disc.*, history and description of the growing uses of Tussur silk, 649
 Debenham, W. E., *disc.*, impressionism in photography, 75
 Decimal coinage, weights, and measures, *paper* by J. Emerson Dowson, 201; *letter*, Dr. W. W. Hardwicke, 245
 Decorative treatment of natural foliage, *Cantor lectures* by Hugh Stannus, 859, 874, 905, 917
 Delepine, Dr., *disc.*, physical tests in competitive examinations, 26
 Demerara, sugar planting in, 137
 Denmark, ceramics in, 277
 Donaldson, Hunter, *disc.*, use of cloisonné for decoration, 387; *disc.*, decorative plaster-work, 453
 Douglas, Prof., *disc.*, vicissitudes in the story of China, 490
 Doulton, Sir Henry, *chair*, the use of cloisonné for decoration, 375
 Dowson, J. Emerson, *paper*, decimal coinage, weights, and measures, 201
 Drawing Society of Great Britain and Ireland, 605; report of council, 682
 Dredge, James, *paper*, Chicago international exhibition of 1893, 32; thanks voted to, for *paper*, 657; *letter*, F. W. Fletcher, 63; annual meeting, 686
 ——— and Sir Henry Trueman Wood, report on a visit made to Chicago, in September, 1891, 887
 Drysdale, Dr. Charles, *disc.*, Indian village communities, 418
 Dyes, fast and fugitive, *paper* by J. J. Hummel, 535; *letters*, F. Aumonier, 566; J. J. Hummel, 588
 Dysart, Earl of, *disc.*, the proposed Irish channel tunnel, 243

E.

Earthenware, Budapesth, exhibition of, 227, 328
 Easty, J., *disc.*, bimetalism, 471
 Egerton of Tatton, Lady, *chair*, history and description of the growing uses of Tussur silk, 608
 Eggs (Canadian), 834
 Electric lighting progress in London, *paper* by F. Bailey, 51
 Electrical transmission of power, *Cantor lectures* by G. Kapp, 687, 699, 711; *syllabus*, 228
 Electricity in relation to the human body; its dangers and its uses, *paper* by H. N. Lawrence and A. Harries, M.D., 316; *letters*, J. S. Pennington, 553; Dr. Harries, 565
 Elephant leather, 674
 Elgar, Dr. Francis, *chair*, steam lifeboats, 126
 Enamels and enamelling, *paper* by J. Starkie Gardner, 331
 Europe, Eastern, public lighting in, 829
 European flax trade, 834
 Examinations, competitive, physical tests in. *paper* by F. Galton, F.R.S., 19
 EXAMINATIONS, SOCIETY OF ARTS:—
 1891 notice, 513
 Offer of prizes, 81
 Report of council, 682
 Music, practical, report of council, 683
 Special examination for School Board teachers, 903
 1892 programme, 903
 EXHIBITIONS:—
 Budapesth earthenware, 227, 328

Bulgarian, 936
 Chicago, 1893 (*see* "Chicago")
 Jamaica, 734
 Madrid American, 842, 936
 Odessa (1894), 822
 Paris, proposed exhibition of fine art prizes, 834
 Tasmania, 243

F.

Farrer, Sir Thomas, *letter*, hall-marking of silver plate, 172
 Fibre-cleaning machines in the Bahamas, 913
 Fibres (vegetable) of Trinidad, 325
 Fildes, Luke, R.A., *chair*, illustrated journalism, 173
 Finance, report of council, 685
 Financial statement, 1891, 655
 Flax culture in Russia, 551
 — trade, European, 834
 Fleming, E. L., *paper*, sources and applications of borax, 524
 Fleming, Dr. J. A., silver medal presented to, 13
 Fletcher, F. W., *letter*, Chicago exhibition, 63
 Flour milling, modern, *paper* by J. Harrison Carter, 299; *letter*, J. Sheppard, 327
 Foliage (natural), decorative treatment of, *Cantor lectures* by H. Stannus, 859, 874, 905, 917; *syllabus*, 402
 Food consumption in Vienna, 362
 Forbes, Prof., George, F.R.S., *disc.*, electric lighting progress in London, 61
 FOREIGN AND COLONIAL SECTION:—
 Meetings of the committee, 51, 249
 Report of council, 678
 Alteration of hour of meeting, 105
 1st Meeting:—"Chartered companies in Africa," by Commander V. Lovett Cameron, C.B., 249
 2nd Meeting:—"Recent development of Tasmanian industries," by Sir Edward N. C. Braddon, K.C.M.G., 363
 3rd Meeting:—"Some vicissitudes in the story of China," by Sir Thomas Wade, G.C.M.G., K.C.B., 475
 4th Meeting:—"Armenia and its people," by Captain J. Buchan Telfer, R.N., 567
 Forest production of Madagascar, 797; of Brazil, 933
 Forestry of Austria, 858; of Annam, 16; of Hungary, 185; of Tasmania, 672; of Zululand, 833
 Foster, Clement Le Neve, D.Sc., appointed Professor of Mining, Royal College of Science, 92; *chair*, sources of petroleum and natural gas, 421
 Fothergill prize, notice, 591
 Foundling asylums in France, 808
 Foxwell, Prof. H. S., M.A., *chair*, bimetalism, 456
 France, barley culture in, 15; tulle industry in, 157; process of firing porcelain in, 401; curing codfish in, 773; foundling asylums in, 808; centres of silk industry, 855
 French railways, roads, and canals, 246
 — wine and cider production in 1890, 266
 — watches, 774
 Frewen, Moreton, *disc.*, bimetalism, 472
 Fruit, American tinned, 78

G.

Galton, Sir Douglas, K.C.B., F.R.S., *disc.*, physical tests in competitive examinations, 27
 Galton, Francis, F.R.S., *paper*, physical tests in competitive examinations, 19
 Gardner, J. Starkie, *paper*, enamels and enamelling, 331; *disc.*, use of cloisonné for decoration, 387
 Gaseous illuminants, *Cantor lectures* by Prof. Vivian B. Lewes, 81, 94, 106, 117, 141; *syllabus*, 2; *letter*, W. Wilkinson, 520
 Gem mining in Siam, 17
 German technical museums, 114
 Germany, home industries in, 99; willow-ware manufacture in, 673

Glass-painting, *paper* by H. Arthur Kennedy, 591
 Gomme, G. L., *disc.*, Indian village communities, 416
 Gordon, J. G., silver medal presented to, 13
 Gordon, Robert, *paper*, economic development of Siam, 283
 Goslin, S. B., *disc.*, uses of petroleum in prime motors, 517
 Grant-Duff, Right Hon. Sir Mountstuart, G.C.S.I., C.I.E.,
chair, the Periar irrigation projects, 555; *chair*, the study
 of Indian history, 658
 Granville, Earl, K.G., *obituary*, 389
 Green, A. G., C. F. Cross, and E. J. Bevan, *paper*, photo-
 graphy in aniline colours, 150; silver medal awarded to
 them, 657
 Green, J. F., *paper*, steam lifeboats, 127; silver medal
 awarded to, 657
 Griffiths, Mr., *disc.*, Tasmanian industries, 370
 Griggs, W., *letter*, lithography, 200
 Guiana (Dutch), india-rubber industry of, 886
 Gutta-percha tree at Singapore, 848

H.

Haden, T. Seymour, *letter*, impressionism in photography, 74
 Hagopian, G., *disc.*, Armenia and its people, 584
 Hall-marking of silver plate, *paper* by E. J. Watherston, 161
 Hallowes, William, *obituary*, 80
 Hamilton, Colonel A. C., R.E., *chair*, chartered companies
 in Africa, 249
 Harbours, natural and artificial, *paper* by F. H. Cheesewright,
 345
 Harcourt, L. F. Vernon, *disc.*, harbours, 360
 Hardwicke, Dr. W. Wright, *letter*, decimal coinage, 245
 Harries, Arthur, M.D., and H. Newman Lawrence, *paper*,
 electricity in relation to the human body, 316; *letter*, 565
 Hasted, Colonel J. O., *paper*, the Periar irrigation project,
 Madras Presidency, 555
 Hawkshaw, Sir John, F.R.S., *obituary*, 605
 Hayter, Harrison, *disc.*, the proposed Irish channel tunnel,
 241
 Heaton, Clement, *disc.*, enamels and enamelling, 344; *paper*,
 the use of cloisonné for decoration in ancient and modern
 times, 375; *disc.*, glass painting, 603
 Hemp cultivation in Italy, 48; in the Philippine Islands,
 552; in Smyrna, 186
 Henchman, Mr., *disc.*, electricity in relation to the human
 body, 323
 Hibberd, James Shirley, *obituary*, 18
 Hill, Sir John, and the Society of Arts, 853
 Hindostan, Mint of, in the 16th century, by A. Wingham, 775
 Hipkins, A. J., *Cantor lectures*, construction and capabilities
 of musical instruments, 739, 751, 763; *syllabus*, 139
 Home industries in Germany, 99
 Hong Kong, rice cleaning in, 808
 Hope, Sir Theodore C., K.C.S.I., silver medal presented to,
 13; *chair*, hall-marking of silver plate, 161; *disc.*, Periar
 irrigation project, 563
 Horse breeding in New South Wales, 277
 Horticulture (technical), 914
 Horton, Dana, *disc.*, bimetalism, 472
 Howard lectures, report of council, 682
 Hughes, John, *disc.*, durability of pictures painted with oils
 and varnishes, 399
 Human, H., *disc.*, modern flour milling, 311
 Hummel, J. J., *paper*, fast and fugitive dyes, 535; *letter*, 585;
 silver medal awarded to, 657
 Hungary, commercial and industrial condition of, 102;
 forests of, 185
 Hunt, W. Holman, *chair*, durability of pictures painted with
 oils and varnishes, 391
 Hygiene, congress of, 115, 249; medals offered under Shaw
 trust, 375; report of council, 684

I.

Illustrated journalism, *paper* by Carmichael Thomas, 173
 Imperial institute, report of council, 684

Impressionism in photography, *paper* by G. Davison, 65
 India, cultivation of oranges in, 844; sugar in, 795; Russian
 and American oil in, 822
 India-rubber industry of Dutch Guiana, 86
 Indian coal production, 726
 ——— government publications, 328
 ——— history, study of, *paper* by C. L. Tupper, 658
 ——— preserves, 112

INDIAN SECTION :—

Meetings of the committee, 31, 249; report of council,
 677; alteration of hour of meeting, 105
 1st Meeting :—"Hall-marking of silver-plate, with
 special reference to India," by Edward J. Watherston,
 161
 2nd Meeting :—"The economic development of Siam,"
 by Robert Gordon, M.Inst.C.E., 282
 3rd Meeting :—"The Indian village communities, with
 special reference to their modern study," by B. H.
 Baden-Powell, C.I.E., 403
 4th Meeting :—"The Periar irrigation project, Madras
 presidency," by Col. J. O. Hasted, R.E., 555
 5th Meeting :—"History and description of the growing
 uses of Tussur silk," by Thomas Wardle, 608
 6th Meeting :—"The study of Indian history," by Charles
 L. Tupper, 658

INSTITUTIONS IN UNION :—

Gateshead, North Eastern Railway literary institution,
 903
 London, central young men's Christian association,
 Exeter-hall, 19
 Rochdale, engineering school and government school of
 science and art, 903
 Irish channel tunnel, proposed, *paper* by Sir Roper Leth-
 bridge, 235
 Iron and wood industries of Sweden, 397
 Italy, cultivation of hemp in, 48; preparation of macaroni in,
 737

J.

Jackson, Hamilton, *disc.*, glass painting, 603
 Jamaica exhibition, 734
 Japan, orange cultivation in, 932
 Jeans, J. S., *disc.*, Chicago exhibition, 46
 Johnston, William, M.P., *disc.*, the proposed Irish channel
 tunnel, 243
 Jones, Mr., *disc.*, electricity in relation to the human body,
 323
 Journalism, illustrated, *paper* by Carmichael Thomas, 173
 Juvenile lectures, "Mimicry in animals," by E. B. Poulton,
 M.A., 93, 105; report of council, 680

K.

Kapp, Gisbert, *Cantor lectures*, electric transmission of
 power, 687, 699, 711; *syllabus*, 228
 Kath, or pale catechu, 156
 Kennedy, A. B. W., F.R.S., *disc.*, electric lighting progress
 in London, 61
 Kennedy, C. M., C.B., *disc.*, Chicago exhibition, 46; annual
 meeting, 686
 Kennedy, H. Arthur, *paper*, glass painting, 591
 Kensington (South), Museum, designs, 774
 Kew reports, 29
 Kohlsaas, H. H., *disc.*, Chicago exhibition, 47
 Krall, C., *disc.*, use of cloisonné for decoration, 388

L.

Landon, F. H., *disc.*, economic development of Siam, 297
 Laurie, A. P., *paper*, on the durability of pictures painted
 with oils and varnishes, 392; silver medal awarded to, 657
 Lawrence, H. Newman, and Arthur Harries, M.D., *paper*,
 electricity in relation to the human body, 316
 Leather industry of Mexico, 103

Leather, elephant, 674
 Lectures, Howard, report of council, 682
 ———, Juvenile, mimicry in animals, by E. B. Poulton, M.A., 93, 105; report of council, 680
 ———, Popular Afternoon, the science of colour, by Capt. Abney, C.B., D.C.L., F.R.S., 249, 269, 281, 315, 331; report of council, 680
 Leighton, John, *disc.*, impressionism in photography, 76; *disc.*, illustrated journalism, 185; *letter*, lithography, 246
 Leitner, Dr., *disc.*, study of Indian history, 670
 Leng, J. B., *disc.*, the proposed Irish channel tunnel, 242
 Lethbridge, Sir Roper, K.C.I.E., M.P., *paper*, the proposed Irish channel tunnel, 235
 Levant, sponge fisheries of the, 853
 Lewes, Prof. Vivian B., *Cantor lectures*, gaseous illuminants, 81, 94, 106, 117, 141; *syllabus*, 2
 Liberty Lazenby, silver medal presented to, 13
 Library, additions to the, 870
 Lifeboats, steam, *paper* by J. F. Green, 127
 Lighting (public), in Eastern Europe, 829
 Limestone industry in the United States, 833
 Linton, Sir James D., P.R.I., *chair*, lithography, 189
 Liquorice plant in Turkey, 845
 Lithography, a finished chapter in the history of illustrative art, *paper* by W. Simpson, 189; *letters*, J. Leighton, 246; Wyatt, Papworth, 246
 Lofoden cod fisheries, 735
 London, trees in, 79
 Longden, H., *chair*, enamels and enamelling, 331; *disc.*, decorative plaster-work, 454
 Low, Sir Hugh, G.C.M.G., *disc.*, economic development of Siam, 296
 Lyall, Sir Alfred, K.C.B., K.C.S.I., *chair*, some vicissitudes in the story of China, 475; *disc.*, study of Indian history, 669
 Lye, W. T., *disc.*, photography in aniline colours, 155

M.

Macaroni in Italy, preparation of, 737
 McCullough, F. W., *disc.*, the proposed Irish channel tunnel, 240
 MacLagan, General, *disc.*, study of Indian history, 670
 Maclear, Capt. J. P., K.N., *disc.*, methods and processes of the ordnance survey, 264
 Madagascar, agricultural products of, 748; forest production of, 797
 Madrid American Exhibition, 842, 936
 Mahogany trade of Honduras, 91
 Manganese ores in the United States, 798
 Manuel, R., *disc.*, colonisation and its limitations, 275; *disc.*, bimetalism, 470
 Marriage, Mr., *disc.*, modern flour milling, 311
 Martin, J. Biddulph, *disc.*, decimal coinage, weights, and measures, 224
 Maskell, Mr., *disc.*, impressionism in photography, 74

MEDALS:—

Presentation of, session 1889-90, 13
 Albert, list of awards, 281, 315; awarded to Sir F. Abel, K.C.B., 657; report of council, 680; presented by H.R.H. the Prince of Wales to W. H. Perkin, F.R.S., and Sir F. Abel, F.R.S., 739
 Drawing society, report of council, 682
 Fothergill, offer, 591; report of council, 682
 Mulready, offer, 687; report of council, 681
 Owen Jones prizes, successful candidates, 823; offer of prizes, 835; report of council, 681
 Shaw trust, offered to Congress of Hygiene and Demography, 375; report of council, 682
 Stock, offer, 687; report of council, 681
 Society's silver medals for papers read session 1889-90, presented, 13; session 1890-91, awarded to J. F. Green, A. C. Green, C. F. Cross and E. J. Bevan, C. Thomas, Sir C. Wilson, A. P. Laurie, W. Robinson, J. J. Hummel, Sir E. N. C. Braddon, Sir T. Wade,

B. H. Baden Powell, T. Wardle, C. L. Tupper, W. Simpson, G. T. Robinson, 657; report of council, 681
 Society's bronze medals, presented to candidates in musical examinations, 14; for drawing, report of council, 682

MEETINGS OF THE 137TH SESSION:—

ANNUAL MEETING, 675

ART (APPLIED) SECTION (*see* "Art, Applied")

FOREIGN AND COLONIAL SECTION (*see* "Foreign")

INDIAN SECTION (*see* "Indian")

ORDINARY:—

Report of council, 676

Programme for session, 1

1st Meeting:—Opening address by the Attorney-General, M.P., chairman of the council, 5

2nd Meeting:—"Physical tests in competitive examinations," by Francis Galton, F.R.S., 19

3rd Meeting:—"The Chicago exhibition, 1893," by James Dredge, 31

4th Meeting:—"Electric lighting progress in London," by F. Bailey, 51

5th Meeting:—"Impressionism in photography," by George Davison, 65

6th Meeting:—"Steam lifeboats," by J. F. Green, 127

7th Meeting:—"Photography in aniline colours," by A. G. Green, C. F. Cross, and E. J. Bevan, 150

8th Meeting:—"Illustrated journalism," by Carmichael Thomas, 173

9th Meeting:—"Decimal coinage, weights, and measures," by J. Emerson Dowson, 201

10th Meeting:—"The proposed Irish channel tunnel," by Sir Roper Lethbridge, K.C.I.E., M.P., 235

11th Meeting:—"Methods and processes of the ordnance survey," by Colonel Sir Charles Wilson, K.C.B., K.C.M.G., F.R.S., 257

12th Meeting:—"Colonisation and its limitations," by E. J. Ravenstein, 269

13th Meeting:—"Modern flour milling," by J. Harrison Carter, 298

14th Meeting:—"Electricity in relation to the human body," by H. Newman Lawrence and Arthur Harries, M.D., 316

15th Meeting:—"Harbours, natural and artificial," by F. H. Cheeswright, 345

16th Meeting:—"The durability of pictures painted with oils and varnishes," by A. P. Laurie, 391

17th Meeting:—"The sources of petroleum and natural gas," by Wm. Topley, F.R.S., 421

18th Meeting:—"Bimetalism," by Sir Guilford Molesworth, K.C.I.E., 455

19th Meeting:—"The uses of petroleum in prime motors," by William Robinson, M.E., 491

20th Meeting:—"The sources and applications of borax," by E. L. Fleming, 523

21st Meeting:—"Fast and fugitive dyes," by Prof. J. J. Hummel, 535

Meldola, R., F.R.S., *Cantor lectures*, photographic chemistry, 787, 799, 812; *syllabus*, 279

Members, list of, notice, 65; report of council, 685

Memorial tablets, report of council, 684

Mexican leather industry, 103

Mimicry in animals, *Juvenile lectures* by E. B. Poulton, 93, 105; report of council

Mineral resources of New South Wales, 835; of Brazil, 933

Mines of New Caledonia, 830

Mining in Queensland, 372; in Western Australia, 86

Mint of Hindostan in the 16th century, 775

Molesworth, Sir Guilford, K.C.I.E., *disc.*, decimal coinage, weights, and measures, 225; *paper*, bimetalism, 456; *disc.*, Periar irrigation project, 562

Montagu, Samuel, M.P., *disc.*, decimal coinage, weights, and measures, 224

Morley, W. M., *disc.*, electric lighting progress in London, 61
 Morgan, Delmar, *disc.*, Armenia and its people, 586
 Morocco, sacred citron of, 821
 Moulton, J. Fletcher, Q.C., F.R.S., *disc.*, impressionism in photography, 76
 Mullins, General, *disc.*, Periar irrigation project, 563
 Murray, Mr., *disc.*, chartered companies in Africa, 256
 Museums (technical) in Germany, 114
 Musical instruments, construction and capabilities of, *Cantor lectures* by A. J. Hipkins, 739, 751, 763; *syllabus*, 139

N.

New Caledonia, mines of, 830
 New South Wales, asbestos in, 606; mineral resources of, 835; horse breeding in, 277
 Newman, P. H., *disc.*, impressionism in photography, 77
 Nicaragua Canal, 100
 Ningpo, silk culture in, 27
 Norman, Henry, *disc.*, economic development of Siam, 297

O.

OBITUARY:—

Report of council, 685
 Barrett, William Alexander, 914
 Granville, Earl, K.G., 389
 Hallows, William, 80
 Hawkshaw, Sir John, F.R.S., 605
 Hibberd, J. Shirley, 18
 Perkins, Loftus, 533
 Smith, Willoughby, 750
 Thomson, Dr. William, Archbishop of York, 103
 Wyon, Leonard C., 810
 Odessa exhibition, 822
 O'Halloran, J. S., *disc.*, Tasmanian industries, 371
 Oil, Russian and American, in India, 822
 Oil (olive) in Spain, 698
 Oils and varnishes, durability of pictures painted with, *paper* by A. P. Laurie, 392; *letter*, W. F. Reid, 437
 Olive cultivation in Northern Persia, 278
 Orange cultivation in Japan, 952; in India, 844
 Ordnance survey, methods and processes of the, *paper* by Sir Charles Wilson, K.C.B., 258
 Orrock, James, silver medal presented to, 14; *disc.*, lithography, 199
 Owen, Mr., *disc.*, sources and application of borax, 530
 Owen Jones prizes, successful candidates, 823; offer of prizes, 835

P.

Paget, Arthur, silver medal presented to, 13
 Pagliardini, T., *disc.*, decimal coinage, weights, and measures, 226
 Palestine, viticulture in, 762
 Papworth, Wyatt, *disc.*, lithography, 246; *disc.*, decorative plaster-work, 453; *disc.*, glass painting, 602; scrutineer, 675
 Paraguay, resources and industries of, 750
 Paris theatres, receipts in 1890, 374
 Patent-office report, 724
 Payne, Alexander, *disc.*, methods and processes of the ordnance survey, 264
 Pennington, J. S., *letter*, electricity in relation to the human body, 553; *disc.*, Periar irrigation project, 563
 Periar irrigation project, Madras Presidency, *paper* by Col. J. O. Hasted, 555; *letter*, Sir Arthur Cotton, 589
 Perkin, W. H., F.R.S., Albert medal presented to, by H.R.H. the Prince of Wales, 739
 Perkins, Loftus, *obituary*, 533
 Persia (northern), olive cultivation in, 278
 Persian carpet weaving, 731

Petroleum, uses of, in prime motors, *paper* by Prof. Wm. Robinson, 492; *letters*, W. C. Unwin, 533; W. Robinson, 553; in Russia, 275; sources of petroleum and natural gas, *paper* by W. Topley, F.R.S., 421
 Pfoundes, Capt., *disc.*, economic development of Siam, 298
 Philippine islands, hemp cultivation in the, 552
 Phœnician commerce, 698
 Photographic chemistry, *Cantor lectures* by R. Meldola, 787, 799, 812; *syllabus*, 279
 ——— conference, notice, 159

Photography, impressionism in, *paper* by G. Davison, 65; in aniline colours, *paper* by A. G. Green, C. F. Cross, and E. G. Bevan, 150
 Physical tests in competitive examinations, *paper* by F. Galton, F.R.S., 19
 Piassava, sources of, 913
 Pictures, durability of, painted with oils and varnishes, *paper* by A. P. Laurie, 392; *letter*, W. F. Reid, 437
 Pine-apple cultivation in the United States, 866
 Plaster-work (decorative), modelled stucco-work, *paper* by G. T. Robinson, 439; *letters*, R. H. Brunton, 521; G. T. Robinson, 531; W. F. Reid, 532; L. Bridger, 565
 Popular lectures, the science of colour, by Capt. Abney, C.B., D.C.L., F.R.S., 249, 269, 281, 315, 331; report of council, 680
 Porcelain, process of firing, in France, 401
 Poulton, E. B., *Juvenile lectures*, mimicry in animals, 93, 105; report of council, 680
 Powell, B. H. Baden, *paper*, Indian village communities, with special reference to their modern study, 403; silver medal awarded to, 657
 Power, electric transmission of, *Cantor lectures* by G. Kapp, 687, 699, 711; *syllabus*, 228
 Precious stones in the United States, 821
 Preece, W. H., F.R.S., *chair*, electricity in relation to the human body, 316
 Prime motors, uses of petroleum in, *paper* by Prof. Wm. Robinson, 492; *letters*, W. C. Unwin, 533, W. Robinson, 553
 Prussia, savings banks in, 362

Q.

Queensland, mining in, 372

R.

Railways of the world, 806; Austro-Hungarian, and the zone system, 843; of Columbia, 138; French, roads and canals, 246; of Cape of Good Hope, 937
 Ravenstein, E. J., *paper*, colonisation and its limitations, 269
 Rawlings, W., *disc.*, modern flour milling, 310
 Rawson, Sir Rawson, K.C.M.G., *chair*, colonisation and its limitations, 269
 Reading-room, contributions to the, 938
 Reckenzaun, A., *disc.*, steam lifeboats, 135
 Redwood, Boverton, *disc.*, sources of petroleum and natural gas, 436; *disc.*, uses of petroleum in prime motors, 516
 Reed, Talbot B., silver medal presented to, 13
 Reid, Walter F., *disc.*, durability of pictures painted with oils and varnishes, 398; *letter*, 437; *letter*, decorative plaster-work, 531
 Rice-cleaning in Hong Kong, 808
 Robbins, Mr., *disc.*, enamels and enamelling, 343; *disc.*, decorative plaster-work, 454
 Roberts, Sir Owen, M.A., F.S.A., *chair*, fast and fugitive dyes, 535
 Roberts-Austen, Prof. C., C.B., F.R.S., silver medal presented to, 14; *disc.*, durability of pictures painted with oils and varnishes, 398
 Robinson, George T., *disc.*, sgraffito, 232; *paper*, decorative plaster-work, modelled stucco-work, 439; *letter*, 531; silver medal awarded to, 657
 Robinson, Prof. Wm., *paper*, uses of petroleum in prime motors, 492; *letter*, 553; silver medal awarded to, 657

Robotom, Arthur, *disc.*, sources and applications of borax, 530
 Robson, Col., *disc.*, decimal coinage, weights, and measures, 225
 Rogers, A., *disc.*, Indian village communities, 417
 Rogers, Mr., physical tests in competitive examinations, 27
 Roscoe, Sir Henry E., M.P., F.R.S., *chair*, decimal coinage, weights, and measures, 201
 Rudler, F. W., *chair*, sources and application of borax, 523
 Ruffer, Dr. Armand, silver medal presented to, 13
 Russia, agricultural industry in Asiatic, 807; petroleum wealth of, 275
 Russian agricultural industries, 832
 — flax culture, 551

S.

Sanderson, Cobden, *disc.*, sgraffito, 233
 Sanderson, Mr., *disc.*, modern flour milling, 311
 Savings banks in Prussia, 362
 Savory, Sir William S., F.R.S., *chair*, physical tests in competitive examinations, 19
 Sawdust and shaving, utilisation of, 374
 Scammony, production of, in Asiatic Turkey, 798
 Scents and perfumes, 327
 Scott, General, A. de C., *disc.*, methods and processes of the ordnance survey, 263
 Scott, W. Lascelles, *disc.*, illustrated journalism, 185
 Selwyn, Admiral, *disc.*, uses of petroleum in prime motors, 517
 Sessional arrangements, 1890-91, 1; 1891-92, 915
 Seton-Karr, W. S., *disc.*, Indian village communities, 416; *disc.*; study of Indian history, 669
 Sgraffito, *paper* by H. Sumner, 229; *letter*, Alan S. Cole, 267
 Shan States (Northern) coalfields of, 588
 Sheppard, J., *letter*, modern flour milling, 327
 Siam, economic development of, *paper* by R. Gordon, 283; *letter*, W. Martin Wood, 327
 —, gem mining in, 17
 Silk culture in Ningpo, 27
 — industry, centres of the French, 855
 — (Tussur), history and description of the growing uses of *paper* by J. Wardle, 608; *letter*, Hyde Clarke, 674; M. M. Bhowanaggee, 726
 Silver plate, hall-marking of, *paper* by E. J. Watherston, 161
 Simon, H., *disc.*, decimal coinage, weights, and measures, 225
 Simpson, William, *paper*, lithography, a finished chapter in the history of illustrative art, 189; silver medal awarded to, 657; *letter*, tughra of the Sultans of Turkey, 857
 Singapore, gutta-percha tree at, 848
 Smartt, W., *disc.*, the proposed Irish channel tunnel, 242
 Smith, General Philip, C.B., *disc.*, electricity in relation to the human body, 323
 Smith, Willoughby, *obituary*, 750
 Smyrna, cultivation of hemp in, 186
 Society of Arts, history of, 762; and Sir John Hill, 853
 Spain, cork industry in, 77; olive oil in, 698
 Sparkes, J., *disc.*, use of cloisonné for decoration, 388
 Spiders and engineers, 725
 Spiller, John, *disc.*, fast and fugitive dyes, 549
 Sponge fisheries of the Levant, 853
 Stannus, Hugh, *disc.*, lithography, 198; *disc.*, sgraffito, 233; *disc.*, decorative plaster-work, 453; *disc.*, fast and fugitive dyes, 549; *Cantor lectures*, decorative treatment of natural foliage, 859, 874, 905, 917; *syllabus*, 402
 Steam machinery for embroidery-making in Switzerland, 856
 Steel, aluminium in steel ingots, 774
 Stokes, Lieut.-Gen. Sir John, K.C.B., silver medal presented to, 13
 Stringer, Mr., *disc.*, modern flour milling, 310
 Stucco-work, modelled, *paper* by G. T. Robinson, 439
 Sugar in India, 795

Sugar planting in Demerara, 137
 Sumner, Heywood, *paper*, sgraffito, 229
 Swan, Howard, *disc.*, electricity in relation to the human body, 323
 Sweden, wood and iron industries of, 399
 Switzerland, watch making industry in, 850; steam machinery for embroidery making in, 856
 Symonds, Captain Loder, *disc.*, bimetalism, 471

T.

Tasmania, forests of, 672
 Tasmanian exhibition, 243
 — industries and prosperity, recent development of, *paper* by Sir E. N. C. Braddon, 363
 Tattersall, Alfred R., *disc.*, modern flour milling, 311
 Tea trade between China and Russia, 869
 Telfer, Capt. J. Buchan, R.N., *paper*, Armenia and its people, 567
 Terra-cotta clays, 886
 Thames conservancy, 932
 Theatres (Paris), receipts of, in 1890, 374
 Thomas, Carmichael, *paper*, illustrated journalism, 173; silver medal awarded to, 657
 Thomas, F. B., *disc.*, hall-marking of silver plate, 172
 Thompson, Prof. Silvanus, D.Sc., F.R.S., *chair*, uses of petroleum in prime motors, 491
 Thomson, Dr. William, Archbishop of York, *obituary*, 103
 Thornton, T. H., C.S.I., *disc.*, hall-marking of silver plate, 170; *disc.*, Indian village communities, 414
 Thornycroft, J. I., *disc.*, steam lifeboats, 134
 Thurlow, Lord, *disc.*, opening meeting, 14
 Thwaite, Mr., *disc.*, uses of petroleum in prime motors, 517
 Timber, Yoruba, 18
 Tobacco culture at Vera Cruz, 89
 Topley, W., F.R.S., *disc.*, the proposed Irish channel tunnel, 242; *paper*, sources of petroleum and natural gas, 421
 Trade, loss of British, from use of British weights and measures, 886
 Treasurer's statement of receipts, payments, and expenditure, 1890-91, 655
 Trees in London, 79
 Trewby, W. G., *disc.*, colonisation and its limitations, 275
 Trinidad, vegetable fibres of, 325
 Trotter, A. P., *disc.*, enamels and enamelling, 344
 Tughra of the Sultans of Turkey, *letters*, Sir George Bird-wood, 809, 846, 867; Hyde Clarke, 822; W. Simpson, 857
 Tull, Jethro, 826
 Tulle industry in France, 157
 Tupper, C. L., *disc.*, Indian village communities, 415; *paper*, the study of Indian history, 658; silver medal awarded to, 657
 Turkey, liquorice plant in, 845
 —, Asiatic, wool production in, 786
 —, production of scammony in, 798
 Tussur silk, history and description of the growing uses of, *paper* by T. Wardle, 608; *letters*, Hyde Clarke, 674; M. M. Bhowanaggee, 726
 United States labour law, 751
 — shipping on the American lakes, 762
 —, manganese ores in the, 798
 —, precious stones in the, 821
 —, increase of farm animals in the, 832
 —, lime industry in the, 833
 —, pine-apple cultivation in the, 866
 —, coal production of the, 885
 Unwin, Prof., F.R.S., *disc.*, uses of petroleum in prime motors, 516; *letter*, 533

V.

Venezuela, agricultural colonies in, 652; economic condition of, 785
 Vera Cruz, tobacco culture at, 89

Verney, F. W., *disc.*, economic development of Siam, 296
 Vesey, J. J., *disc.*, electricity in relation to the human body, 323
 Vienna, food consumption in, 362
 Village communities (Indian), with special reference to their modern study, *paper* by B. H. Baden-Powell, 403
 Viticulture in Palestine, 762

W.

Wade, Sir Thomas, G.C.M.G., K.C.B., *disc.*, some vicissitudes in the story of China, 475; silver medal awarded to, 657
 Walford, Mr., *disc.*, Tasmanian industries, 370
 Walker, Mr., *disc.*, chartered companies in Africa, 257
 Wallace, R. W., *disc.*, electric lighting progress in London, 62
 Wardle, T., *disc.*, fast and fugitive dyes, 548; *paper*, history and description of the growing uses of Tussur silk, 648; silver medal awarded to, 657
 Warnerke, Mr., *disc.*, photography in aniline colours, 155
 Watches (French), 774
 Watchmaking industry in Switzerland, 850
 Watherston, E. J., *paper*, hall-marking of silver plate, with special reference to India, 161
 Watkin, Sir Edward, Bart., M.P., *disc.*, the proposed Irish channel tunnel, 240
 Webster, Sir Richard, Q.C., M.P., opening address as chairman of council, 6; *chair*, Chicago exhibition, 31; *chair*, methods and processes of the ordnance survey, 257; elected chairman of council, 687
 Weights and measures, decimal, *paper* by J. E. Dowson, 201

Wheatley, H. B., *disc.*, enamels and enamelling, 343; *disc.*, glass-painting, 603
 Whitaker, William, F.R.S., silver medal presented to, 13
 Wilkinson, C. S., mineral resources of New South Wales, 835
 Wilkinson, W., *letter*, gaseous illuminants, 520
 Willow-ware manufacture in Germany, 673
 Wilson, Sir Charles, K.C.B., K.C.M.G., F.R.S., *paper*, methods and processes of the ordnance survey, 258; silver medal awarded to, 652; *chair*, Armenia and its people, 567
 Wine industry of California, 653
 — and cider production in France in 1890, 266
 Wingham, Arthur, the Mint of Hindostan in the 16th century, 775
 Wood and iron industries of Sweden, 399
 Wood, Sir H. Trueman, *disc.*, Chicago international exhibition, 45; *disc.*, methods and processes of the ordnance survey, 264; *disc.*, sources and applications of borax, 530
 — and James Dredge, report on a visit made to Chicago in September, 1891, 887
 Wood, W. Martin, *disc.*, hall-marking of silver plate, 171; *letter*, economic development of Siam, 327; *disc.*, Indian village communities, 418; *disc.*, bimetallism, 471; *disc.*, Periar irrigation project, 564; *disc.*, history and description of the growing uses of Tussur silk, 650; scrutineer, 675; annual meeting, 686
 Wool production in Asiatic Turkey, 786
 Wuensch, E. A., *disc.*, photography in aniline colours, 155; *disc.*, lithography, 199
 Wyles, F., *disc.*, electricity in relation to the human body, 323
 Wyon, Leonard C., *obituary*, 810

Z.

Zululand, forests of, 833

GETTY CENTER LIBRARY



3 3125 00628 9355

